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INDIAN INDUSTRIALISTS' DELEGATION ABROAD

THE Delegation of Indian Industrialists, whose activities in the United Kingdom were briefly recounted in this Journal (*Current Science*, July 1945, p. 165), have now returned home from the United States travelling *via* England. Many of the individual members have been interviewed by the Press on various aspects of their work abroad. The press accounts of the opinions and impressions of the individual members have not always been easy to piece together and at times have tended to be slightly confusing. It was thus necessary to issue an authoritative statement on behalf of the Delegation and this has been now done in the form of an official Report which has been released by Dr. P. S. Lokanathan, Secretary to the Delegation. The Report covers a wide range of problems, some of which, like the political background of the country, the allotment of Dollar exchange and the liquidation of blocked sterling assets, primarily not within the purview of *Current Science*. The following excerpts from the Report of the Secretary are, however, of interest to men of science and technology.

"We were ... enabled in the aggregate to get a general picture of British and American industry, covering an extremely wide range of industrial activity. .... Our impression was that American industry is in many respects well ahead of British industry in efficiency and in equipment used. In the field of research, on the other hand, it seemed to us that Britain was at least as advanced as America. In both countries applied and theoretical research is being conducted on a gigantic scale and money lavished on it by both Government and private enterprise.

"We are much impressed by the improvements in technique and the scientific advances effected in both countries. ..... The immense complexity of modern industry particularly in the engineering and chemical fields ..... have convinced us that if India's industrialisation is to be as speedy as public opinion and her economic situation demand, we should unhesitatingly seek to import ready-made technique and industrial "know-how" from these two and other countries.

"With the possible exception of medium-sized, general purpose machine-tools .... the demand for capital equipment ... is so great that deliveries and prices are bound to be unfavourable for a considerable time. .... There seems to be no chance of getting any (textile machinery) for a long time from America while deliveries from England cannot be expected under two years. In the case of other types of capital equipment, such as power plants, heavy and special purpose machine tools, transport equipment, electrical equipment, mining machinery, forging, foundry and chemical plants, etc., delivery periods vary greatly from six months to two years or more but they are generally longer in England than in the U.S.A.

"We believe that in a couple of years or so prices as well as deliveries will become easier and that the machinery then available will be of a more advanced and efficient type. ... It would be inadvisable for industrialists in India to be in a hurry to purchase capital equipment under present conditions except, of course, where requirements are so urgent or of such a nature that they cannot be postponed. ... We should like to sound a note of warning against the purchase and installation of old and worn-out equipment which would cripple India's capacity to compete in later years. ...

"... of war surplus stock ... being either new or practically new ... prices will range

from 50 to 60 per cent. of their original cost ... we should like to impress upon Government and the business community in India the necessity and urgency of constituting in both countries an organisation which would locate available equipment, inspect and report on it when necessary, canalise all enquiries from India and furnish machinery for their procurement from the various surplus disposal boards.

"We have returned from our trip enriched with first-hand knowledge of the economic and industrial conditions and prospects in Great Britain and the United States and with a better informed appreciation of the significance, scope, needs and complexities of modern industry. We have come back more than ever convinced that only by means of large-scale industrialisation backed by massive scientific research and education, can India hope to emerge from her poverty and distress and rapidly build up the high standard of living to which her people are entitled and so desperately aspire."

This valuable Report does not make pleasant reading to those who believe that the industrial development of India is merely a question of planning on paper, ordering the requisite equipment from just across the counter, install it and begin to collect profits. It is refreshing to notice the emphasis placed by these veteran industrialists that the large-scale industrialisation of the country should be "backed by massive scientific research and education". The Delegation have done a signal service to the country in publishing this Report which is characterised by objective and critical discernment.

COMMODITY COMMITTEES AND COMMUNAL PROSPERITY

IT was indeed a happy moment when the Member of the Government of India for Education, Health and Lands, struck the fruitful idea of creating Commodity Committees for ensuring the education and collaboration of the communities of India for the development of their economic resources. This plan has been welcomed by *Current Science* as an effective instrument for the creation of a new epoch of scientific and industrial awakening in the country.

At the present time five such Committees have been constituted and are in a working condition, namely, The Indian Central Cotton Committee, The Indian Lac Cess Committee, The Indian Central Jute Committee, The Vegetable Oil Committee and the latest addition, the Coconut Committee.

Considering the possible expenditure of public money and material on these Committees and expectations of increased economic prosperity arising from their activities, it seems necessary to review not only their past working so far but also to indicate the general policy which they must pursue in order to realise their full potentialities of development.

At the outset it is necessary to emphasise that in the creation of institutions of this sort, the main object should be to foster an original output of new thoughts, new knowledge and new modes of utilisation of the valuable commodities of India providing suitable opportunities for self-expression of national professional talent in the connected fields of scientific research, skilful industrial and agricultural application of new knowledge and business enterprise required for large-scale production of new products. Obviously the best way of realising this consummation is the organisation of an experimental industrial laboratory for each commodity under the leadership of competent and patriotic leader of scientific research interested in the subject who will be a whole-time officer adequately financed and authorised for the free exploitation and investigation of the industrial and scientific potentialities of the commodity concerned. Without such a nuclear activity it will be useless to expect an adequate economic development of the resources of this country. Judged from this standpoint scientific India can well complain that the current administrative policy has failed to give the scientific Indian researcher the leading place in the constitution and working of these Commodity Committees. On the other hand, by placing commercial and political foreign interests at the head of affairs in the creative realm of future developments for the economic benefit of the country the cart has been put before the horse at too early a stage of our Country's new era of industrial regeneration.

To take one example, the oldest of these Committees, namely, the Indian Central Cotton Committee, has been in existence since 1921 and in a Report of their work during the last twenty years published in 1942, the attention which they have paid to Indian scientific research is so scanty and indifferent that it almost deserves thorough overhauling. Below is quoted a paragraph on "Research Students" from page 31 of the Report in illustration of the importance given to Indian research by this Committee, and of their utter neglect of leading national scientific talent in organising their programmes.

> "In the beginning, the Committee had perforce to undertake the training of research scholars in the various branches of science pertaining to cotton for employment on its research schemes or in the Provincial Agricultural Departments. Gradually, however, the necessity for this has disappeared and scholarships are now, generally speaking, only granted when need for specially trained workers arises in connection with the Committee's schemes or in Agricultural Departments. Sometimes scholarships are also awarded for specialised training at recognised institutions abroad or in the Committee's Cotton Genetics Research Scheme at the Institute of Plant Industry, Indore."

If, on the other hand, there had been a continuous harnessing of all-round National Scientific talent in the elaboration of schemes of research for the adequate utilisation of cotton and its associated by-products, India might be producing by now, commercial quantities of furfural, laevulinic acid, raffinose, tocopherol and a few other valuable industrial products for internal consumption and prosperity (unpublished work of K. Karamchandani under the writer's guidance).

The progress of the Lac Cess Committee during the last fifteen years of its existence exhibits equally depressing features in spite of a large volume of reported investigations both in India and abroad. The root of the depression lies in the fact that Indian workers who were induced to make useful though disjointed contributions to existing knowledge both in India and in London, have never been entrusted with the necessary freedom and authority to consolidate their ideas to their logical consummations. The tendency has been more to fill up existing jobs with indifferent personnel, than to discharge a national responsibility with due consideration of the claims of professional and economic interests involved therein.

The only way to remedy this state of affairs lies in the constitution of a permanent committee of leading Indian scientists of all sciences, pure and applied, who should be authorised by the Government to appoint their own expert sub-committees for each commodity to initiate new schemes of research in relation to the particular commodity, with adequate funds for the creation of necessary laboratory and educational facilities at suitable centres throughout India.

The idea of sending scholars abroad for specialised training with a view to develop our country's resources has very often proved to be more a recreation than a real aid to the creation of suitable opportunities for local scientific talent for the self-reliant organisation of suitable programmes of research. It should be remembered in this connection that in spite of ignorant and ignoble attempts by interested parties to disintegrate the scientifically organised communal solidarity of India, the communities in India have still not lost their hereditary and inborn professional responsibilities and efficiencies. The disinterested research scholar, the public-spirited administrator, the philanthropic businessman and landed aristocracy, and the self-respecting skilled artisan are still alive in India, each with his inborn professional intuitions and equipment. It should be the sole aim of each Commodity Committee to bring together the goodwill and enthusiastic co-operation of members of each of these four communities into active collaboration in an experimental research laboratory intended for the exploitation of the industrial potentialities of each of the valuable commodities of India.

In the writer's opinion there is no half-way house between a free and full communal prosperity for India and the necessity for the establishment of laboratory facilities for the mutual understanding and planned collaboration of members of the professional communities of India in the cause of the economic utilisation of our country's material resources in the immediate future.

It is therefore, earnestly hoped that before long, there will be a definite change of orientation of policy in the working not only of the present Commodity Committees, but also of others that are likely to come into being in the near future, so as to make these organisations real and powerful instruments for the creation of National outlook, professional personnel, and economic communal prosperity.

P. Ramaswami Ayyar.

SIR A. L. MUDALIAR

THE appointment of Sir A. Lakshmanaswamy Mudaliar as Vice-Chancellor of the University of Madras for a second term of office is an event which gives the deepest satisfaction to educational circles in South India. At this time when many problems relating to University Education await solution, the Madras University is fortunate in having one of the foremost of Indian Educationalists at the helm of affairs to guide her destinies.

After graduating from the Madras Christian and Medical Colleges, Sir Lakshmanaswamy began his career as a member of the Provincial Medical Service and was connected with the Government Hospital for Maternity and Child Welfare, Madras. He joined the hospital as an Assistant and later rose to the position of its Chief. The very high standard of his work and scholarship earned for him a front rank in the medical profession as a leading authority on Obstetrics and Gynæcology. He contributed much to the scientific side of his subject, wrote a well-known text-book, and trained a large number of medical men for professional as well as scientific work. All this was duly recognised by his election to the Fellowship of the Royal College of Obstetricians and Gynæcologists, England. His scientific enthusiasm did not minimise the human interest he took in his work; all through his career, when administrative responsibilities of various types weighed heavily, he found time to continue his professional work and maintain contact with the Hospital to which he was so long attached and for which he did so much to develop it as the leading Institution of its kind in India. The medical profession in South India also knows him as an inspiring teacher, for he was Lecturer and later Professor of his subject at the Madras Medical College. His appointment in 1937 as Principal of the College was a notable event, as it marked a departure from custom, he being the first Indian to hold this key position of medical education in South India.

Sir Lakshmanaswamy's connexion with the Madras University dates from about twenty-five years ago, as a member of the Academic Council and the Senate. His deep study of University problems soon found him in the front line of University administration and in the Syndicate, whose membership he held without interruption. The period of his active work at the University with successive Vice-Chancellors, particularly from 1930-1940, was one of the most fruitful periods of expansion of its activities, in the starting of the different Research Departments and adequately housing them in the University area. Along with the then Vice-Chancellor, Sir K. Ramunni Menon, he took the keenest interest in the starting of the three Scientific Laboratories of the University, *viz.*, Botany, Zoology and Biochemistry,

in 1933. He acted as Vice-Chancellor in 1941 and was elected for his first term of Office in 1942.

The first term of Office recently completed by Sir Lakshmanaswamy is noteworthy for the great interest which the Madras University took in fostering Technological Education in South India. The importance of Technical education so as to train suitable personnel for industrial work has been stressed in our columns from time to time. Chemical and allied industrial development has been particularly backward in South India owing mainly to the absence of suitably equipped training centres. With his characteristic zeal Sir Lakshmanaswamy took up this cause and succeeded in enlisting the support of the Government and a leading Industrialist, Dr. Alagappa Chettiar, with the result that it was possible, with the co-operation of the Government Engineering College at Guindy, to open a College of Technology in 1944. This College began with courses in Chemical Engineering and has already developed further with arrangement for courses in Textile and Leather Technologies, subjects of special interest to industrial development in South India.

Among the other achievements of the Madras University during this period, particular attention should be drawn to the starting of new graduate courses in Commerce and in Nursing, and to the organisation of short-term post-graduate courses for the Medical Profession.

In the various reconstruction programmes for this country, Sir Lakshmanaswamy has already put in much notable work on the Health and Survey Committee of the Government of India, as the Chairman of the Educational Reconstruction Committee of the University of Madras and as Member of many of the Committees constituted by the Government of Madras. Our very best wishes go to him for the success of his future work and the continuation of the sound and energetic policies on Educational and Medical problems that have so characteristically come from him.

ECONOMIC UTILISATION OF SHARKS IN INDIA

BY
(Miss) INDIRA M. GAJJAR and M. SREENIVASAYA
(Section of Fermentation Technology, Indian Institute of Science, Bangalore)

SHARK LIVER OIL industry in India to-day represents one of the war-born industries, whose survival capacity during the post-war period is solely dependent upon the extent of support which the industry would receive from the Central Government. The industry when consolidated and developed would not only afford employment to tens of thousands of fishermen but also provide a supplementary and desperately needed source of nourishing meat and a rich and exclusive source of an indispensable group of vitamins; in addition, other portions of the carcass now discarded could be made to yield a wide variety of valuable products: hides, active principles, biologicals and fine chemicals. As in the case of herds of cattle and flocks of sheep, the sharks need not be raised; they breed naturally in the depths of the coastal waters of this sub-continent; controlled fishing and scientific management of sharks will ensure a steady supply of this raw material. The sharks, if properly utilised, will serve to conserve the cattle wealth of the country, which has got depleted to an alarming extent during the war period. These are circumstances of compelling significance which entitle the industry to every form of Government support and protection.

In consideration of the national importance of the industry, the Central Government may be expected to grant adequate protection against aggressive foreign competition and extend generous financial support for the prosecution of researches on the fundamental and technological aspects of the industry.

At the moment, the shark liver oil industry, which has made some promising headway during the war, is overshadowed by the complacency, the uncertainty and the indecision which constitute a lamentable feature of post-war planning in this country and by the imminent commencement of the whaling operations by Anglo-Norwegian interests as revealed by a recent broadcast. The threatening aspect of this enterprise becomes apparent if attention is called to the recent discovery that the whale liver is the richest source of "Kitol" which on simple distillation gives vitamin A; This is a direct challenge to the shark liver oil whose recognition as one of the richest sources of vitamin A is largely due to the pioneering investigations of Dr. Sunder Raj and his collaborators.

Since 1940, the Departments of Fisheries in the several maritime Provinces and States have intensified their efforts and achieved a substantial measure of progress in the production of shark liver oil; some of them have also investigated the process of filletting and curing the edible portions of the shark by improved methods. We have not been able to secure reliable data ragarding the annual production of shark liver oil in the country; much less have we been able to obtain information with regard to the total number or weight of sharks caught from the coastal waters of India. Setna[1] (1945) is of the opinion that during the past 4 years an output of a million and a half pounds of oil may not be an extravagant claim. Considering the widespread prevalence of night-blindness and general malnutrition in this country, and assuming that an average deficiency (computed on the entire population) works out to about 20 per cent., the country's requirement of shark liver oil of 10,000 I.u/per gm. potency, will amount to about 28 million pounds per annum. Taking 100 lbs. of liver as the average yield per shark, and assuming that 50 per cent. is the average yield of the oil, it can be calculated that 576,000 sharks will have to be caught per year to satisfy the

urgent human requirements of vitamin A; we have not taken into account the vitamin A deficiency which is believed to be alarmingly widespread among our cattle.[2] Whether our seas could sustain this rate of depletion of sharks, is a point on which expert opinion will have to be elicited.

The total weight of the catch will amount to 576,000 × 1,500 lbs., i.e., 432,000 short tons. The utilisation of the carcass would thus present a problem of considerable magnitude and economic value. The shark, as indicated before, provides, in addition to the oil, other exploitable products. We could not get at any data pertaining to the relative weights of the various organs and tissues which could be obtained by dressing the carcass of a shark. One of us (I.M.G.) has taken up a study of this question and preliminary studies have revealed that the following percentages (Table I) of the more important organs and tissues could be obtained. We have not been able to obtain data with regard to the ductless glands, which might ultimately prove important sources of hormones. We understand that Dr. B. B. Dey, who has done pioneering work in this field, is already engaged on this problem.

TABLE I

Percentages on the body-weight

(All weighings with fresh material)

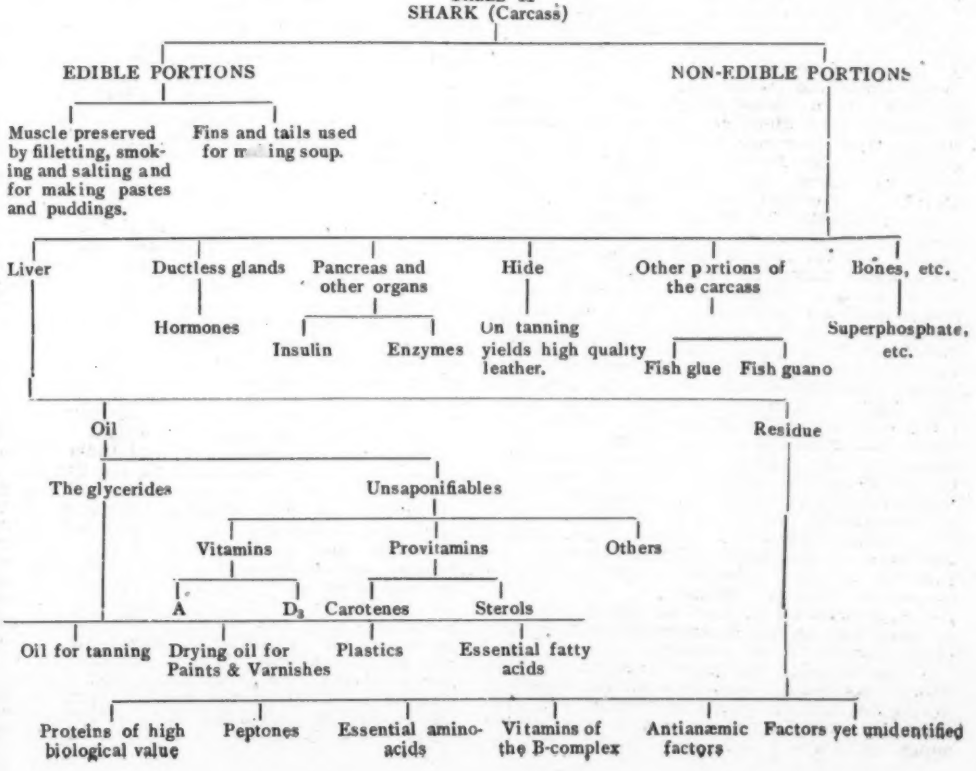
Muscle	45·2	Stomach	2·2
Hide	12·9	Intestines	1·0
Head and Bones	24·2	Blood	0·8*
		Pancreas	0·32
Fins and tail	6·1	Heart	0·12
		Kidney	0·03
Liver	3·3		

*Obtained by bleeding

It will be seen that the annual catch of sharks amounting to 432,000 short tons would give not only the oil for which they are now fished but also considerable quantities of byeproducts which could be processed into a variety of useful materials. The accompanying chart (Table II) will serve to illustrate the scope of these byeproduct industries. Nutritious meats of high biological value from muscles (shark flesh pastes and puddings), hides of exceptional quality and strength, glues and gelatines from fleshings and sinews, proteins, peptones and amino-acids from nitrogen-rich organs and tissues, hormonal extracts from ductless glands, antidiabetic harmones from the pancreas, and vitamin rich concentrates of high antianæmic value from the liver, represent the more important groups of products which portions of the shark carcass (at the moment mostly discarded) could be made to yield.

The meat consisting principally of the muscle of the sharks and the rays, especially those with black-tipped fins, *Carcharinus limbatus*, *Carcharinus bleekeri*, is now being utilised. Small-sized *Carcharinus melanopterus*,

TABLE II



Sphyrna zygœna and *Carcharinus menisorrach* are consumed fresh and are generally administered to women after child-birth. Setna[1] (1945) has recorded that shark flesh is at present being filletted and salted in the fish-curing yards all along the coasts of Bombay and Madras. The product is said to find a ready market in the interior. Recently smoking of shark fillets has been undertaken and the process has been found to give a satisfactory product. Even the fins and the tails of the larger varieties of sharks are considered edible when made into soup; formerly large quantities of this material were being exported to England, Germany and China.

The skin of the shark can be tanned to an extremely useful leather[3] (1922); at the moment, there does not appear to be any organised attempt in this country to utilise this valuable byeproduct. Cameron[4] (1937) has recorded an exceptionally high content of iodine (1·160 per cent.) for the desiccated thyroid glands of certain fish. The possibility of manufacturing potent preparations of insulin has been suggested; many fish possess pancreatic glands which have been found to contain exploitable quantities of this invaluable hormone. According to Tressler[5] (1923) various species of sharks have been examined to determine their relative value as potential sources of insulin. The shark has been found to contain this active principle in a form which can easily be extracted. In these directions, practically no work has been carried out in this country.

We have completed a piece of investigation directed towards the utilisation of the liver residues of the shark as a source of peptones and amino-acids on the one hand, and on the other, of the vitamins of the B-complex, anti-anæmic factors and other physiologically active principles. With regard to the other organs practically no work has been carried out; it is of utmost urgency that work in this direction should be extended immediately; it will serve to lay the foundation for the establishment of a chain of interdependent industries, which together, would contribute towards the stabilisation of the shark liver oil and allied industries.

1. Setna, *J. Sci. Industrial Research*, 1945, **3**, 303. 2. Fernandes, *Indian Farming*, 1940, **1**, 591. 3. Rogers, *Practical Tanning*, 1922, page 574. 4. Chr. Bomskov. *Methodik der Hormonforschung*, Bd. I, 1937, page 311. 5. Tressler, *Marine Products of Commerce*, 1923, page 693.

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STORAGE OF FOODGRAINS

By Dr. A. V. VARADARAJA IYENGAR, D.Sc.
(*Biochemist, Malleswaram, Bangalore*)

IN normal times, the supply and demand for foodgrains and their products could be so adjusted as to entail the holding of minimum stocks for a minimum period of storage. Under conditions of war or of threatened famine, the shortage of foodstuffs in general necessitates the maintenance of large stocks and quite often for longer periods. Even in ordinary times, the storage of food-products has presented many problems in countries where climatic conditions favour generally the deterioration of such materials. This deterioration is usually associated with either a high atmospheric humidity or a high moisture content in the stored product. Humidity and moisture are thus primary factors which control insect attack and mould growth in the stored materials. Besides these, the conditions of storage as well as the conditions in which the grains are received are important factors which determine the loss of foodstuffs in a locality. The problem of storing foodgrains and food-products is thus important requiring close scientific approach for its study. In the present review, it is proposed to summarise the available knowledge on this problem and suggest a simple and practical method for adoption, whereby the loss of foodgrains may be reduced to a minimum.

Conditions for Storing Foodgrains

Foodgrains such as cereals and pulses have certain fundamental characteristics. In the first place, their moisture content is not a fixed entity but is conditioned by the humidity of the atmosphere in which it may be stored. Thus depending upon humidity, the grains take up or lose water. According to Snow[1] *et al.*, cereals take up more moisture than pulses (legumes) at a R.H. of 40-80 per cent. Above 80 per cent. R.H., this absorption is reversed. Gane[2] arrived at similar conclusions independently. The former investigators have, however, recommended safe levels of moisture content for storing different feeding-stuffs. Thus, a moisture content of 15·7 per cent. is the safe limit for short storage of wheat (about three months) while it may be 14·6 for longer periods (over one year). In the case of maize, this safe limit has been fixed at 12·5 per cent. for export purposes. In respect of stored grains, the factor of safety varies to some extent with the different types of products, but broadly it may be fixed at 12-14 per cent. moisture for satisfactory storage, although it could be conveniently lower than this. Secondly, grains with a moisture content of 15 per cent. and above, have a tendency to "heat" up, a feature which is not very desirable, as it affects the quality of the grains. Thirdly, with a moisture content of 15 per cent. and more, conditions are favourable for insects to feed and breed on the material. This is then followed by mould infestation. Wheat, with a moisture content of 17 per cent., has been found to be readily infested by insects, particularly weevils. It must be emphasised here that it is not merely the moisture content of the stored grain, but the R.H. of the atmosphere surrounding the grains is equally important. It is not adequately realised that grains reach equilibrium with the atmosphere and absorb or give up

moisture depending upon the humidity of the air. According to Barton-Wright and Tomkins,[3] mould growth was prevented on flour exposed to a R.H. of 79 per cent. and on bran to a R.H. of 75 per cent. during a period of four months' storage. In discussing the influence of humidity on storing feeding-stuffs, Snow *et al.*,[4] concluded that mould development was conditioned generally by: (1) the R.H. of the atmosphere. (2) The temperature of storage. A humid atmosphere and a temperature of over 20° C. favour strong mould growth. (3) The length of storage period. At a R.H. of 75-100 per cent. mould growth takes place very soon, while below 75 per cent. R.H., the development of moulds is extremely slow though not inhibited. (4) By the type of moulds. In discussing the effect of humidity on insects Germar[5] observed a mortality of 100 per cent. weevils in two days at a R.H. of 20 per cent. and in twenty-two days at R.H. of 100 per cent.

It is evident from the above that the moisture content of the grain at the time of storage and the humidity of the air to which it is exposed are two essential factors requiring careful control if insect and mould attacks are to be avoided during storage. It may be mentioned here that where grains are treated to reduce their moisture content to 10 per cent. or less, weevils are unable to attack such products, and where they are particularly excluded from air as well, the insects cannot carry on active life. Under such a low moisture content heating of the grains does not take place. Loss of grains during storage is thus avoided. The question of dehydrating grains to reduce the initial moisture content to the safe limit has to be considered both from the view-points of the moisture content of the same as well as the atmospheric conditions during such drying. It is obvious the dehydrated material should not be exposed to a high humidity, as water will be absorbed by the grains. Thus, in Burma, it has been observed that rice milled in the dry season, keeps better than that milled in the wet season. Where the reduction in moisture content is small, heating may be resorted to, since the cost involved is not much. Where the grain is highly infested or where it is otherwise very moist, the removal of moisture by heat may not be a profitable one. Thus, in experiments conducted in W. Indies and Mauritius, the doubtful economy of such a procedure was indicated.

Besides controlling the moisture relations of the grains intended for storage, the successful storage of foodgrains involves in the fulfilment of two other essential conditions, *viz.*, (*a*) that the produce to be stored is in a condition suitable for storage at the time of introduction into stores and (*b*) that during the period of storage conditions are established whereby the grains are rendered free from infestation. While it may be possible to treat infested and damaged grains so as to minimise damage, it would be preferable to prevent loss by attention to the provision of suitable stores and to conditions of storage. As a rule, grains are bought in new unused bags in order to minimise infestation from used bags. But there is no guarantee that the grains are primarily examined or tested for freedom from insect attack. Then again, during transport by rail or carts, infestation is not prevented. A great deal of attention is necessary by the transporting authorities in this connection. This primary infestation prior to storage must adequately be prevented. The secondary infestation takes place during storage.

It is clear from the above that in respect of storing foodgrains, the two essential conditions referred to above must be rigorously attended to. It is known that grains are easily attacked by a large variety of insects, such as grain weevils, beetles, flour beetles, flour moths, mites, etc. It is not proposed to consider the insects except in relation to their habits and behaviour to explain the methods of controlling them. In regard to the first condition mentioned above, where grains are intended to be stored for long periods and in large quantities, it would be wise to screen it first so as to eliminate the adult insects as soon as possible after receipt of the same. The material so treated is in a better condition to store inasmuch as the adults—weevils, etc.,—are prevented from laying eggs. The damage resulting from future infestation is largely minimised in this way. The longer this screening is delayed, the greater will be the infestation. In other words, the infestation brought in by the goods to be stored—"the "incoming" population—is more easily controlled than the "resident" population, i.e., the infestation during storage. The former treatment is more easily achieved. In cases of heavy infestation, screening the goods followed by dehydrating to the safety level of moisture referred to in the beginning, would ensure satisfactory conditions and render the grain fit for storage. In this connection, the question of treating containers like gunny bags, in which grain is normally transported, is a very important one. These should be sterilised either by dry heat, sun or by the use of boiling water, before being used again. The rooms wherein the bags were stored with the grain, should be well cleaned and fumigated.

In the matter of storing grains free from insects, this is largely achieved by adhering to conditions of hygiene and to selection of proper storage containers, such as bins for bulk storage. These must be free from holes, crevices, angles, etc., wherein insects reside largely. These bins are capable of being fumigated and sprayed with chemicals, after the contents have been removed. They are capable of being closed airtight so as to prevent contact with the outside air. It is common knowledge that grain weevils and moths thrive best in darkness and in a still, warm atmosphere. Therefore good light and thorough ventilation are generally recommended for storing grains in bags. These are elementary precautions in the storage of grains. When the bins are cleared of their contents, all rubbish and refuse from the stored product should be swept up and completely destroyed. It is not uncommon that such refuse grains are often taken back to the stores just to avoid report of loss on

storage. This dangerous practice cannot be justified on any account. The regular movement of stored grains also acts as a check on the multiplication of moths and weevils. The mixing of fresh stock with that in storage should never be recommended without thoroughly examining both for freedom from infestation. The question of containers for long storage is engaging the attention of authorities in this country and is outside the scope of this article.

The Control of Insect Pests of Stored Grains

In actual practice, the enforcement of the conditions referred to previously, leaves much to be desired, so that infestation of grain by insects and subsequently by moulds has not been eliminated either prior to storage or during storage. In this country, storage of grains is generally in bags and it is only now that the different governments are planning to adopt bulk storage in bins, etc., and control infestation by long-established methods in vogue here and abroad. Infested grains have been subjected to physical treatments such as heat, X-ray, etc., on the one hand, and to fumigants on the other. The former procedure has not been of much avail because of the cost involved in "de-weevilising"* and in reducing the moisture content of infested materials, which are highly moist—the greater the degree of insect attack the greater is the moisture content of the grain. The employment of fumigants has been widespread and much literature has grown on these. Beside these two processes, a simple method of coating grains with certain "inert" dusts has recently been evolved—more in the nature of a prophylactic or protective treatment than a curative one, which the other two are.

In treating infested grains, the degree of infestation is the most important factor, so that each bag or bin must be closely examined by a competent technical staff. In very incipient stages of infestation or where infestation has just commenced, it may be wise to screen the material and subject the residue to a high temperature for a short interval, or *vice versa*. Considerable care is necessary, where heat treatment is to be resorted to. Normally, the ryot exposes the grains to the action of sun's rays for a day or two, winnows the material and stores again. In this way, he is partially dehydrating in addition to removing the insects. Where larger quantities are involved, some form of commercial dryer is needed. During the last War, a mechanical equipment—known as Hess Dryer and Cooler—was evolved in England to process infested grains. In this drier, the infested grain was reconditioned, improved and further damage prevented by subjecting such material to a blast of hot air followed by one of cold air, the grain being dried in this process, most of the mites killed and their bodies recovered. In the Hess Drier and Cooler,[6] "the grain is passed from a band conveyor into a garner where it falls into a chamber containing a series of horizontal racks arranged one above the other, zig-zag fashion. After subjecting it to a hot air blast, the wheat passes into a similar chamber and receives a blast of cold air, then it passes into a hopper beneath and thence is discharged on to a band conveyor. Cold air is drawn through the lower chamber by a powerul fan, is forced over a series of steam coils and then passes over the wheat in the upper chamber". Here heat serves as a sterilising agent, the temperature recommended not exceeding 150° F. which does not affect the quality of the grain. It is never advisable to go above this temperature which is fatal to all insects. This method had been in vogue in U.S.A. and in Australia. The difficulty is one of adequate equipment and the possible repetition of heat sterilisation more than once, should reinfestation set in during storage. In high temperature treatments, the difficulty is again to decide upon the range of temperature non-injurious to the grain but fatal to the contained larvæ. Generally 140° F. is enough to kill all insects but five minutes' exposure to a temperature of 125° F. is just as fatal. For seeds, a temperature of even 150° F. does not affect germination. It is probable that higher temperatures would impair the quality of the grain, affect the baking quality in the case of flour from wheat. In the highly moist condition, depending upon the degree of infestation, denaturation of the proteins cannot be eliminated. Again, the heat treatment has to be carried out when the outside temperature is high. Although heat treatment of grains has not been generally favoured, it may be mentioned here that recently the application of electronics or high frequency current to processing grains has been reported. It has been observed that a temperature of 120-130° F. is easily attained by a 3 kw heater and an exposure of 20-30 seconds seems to be more than adequate for the purpose. The equipment for this process is also less complicated. The generation of high frequency current of at least 100,000 cycles would be required. It has further been observed that the cost of this process is mainly that of generating this frequency.

Control through Fumigation

The only radical method of ensuring freedom of grains from pests is sterilisation, i.e., subjecting the grains to the action of a lethal agent. Although a fumigant is not a lethal agent, the difference between the two is very small. Both should, however, not impair the quality and flavour of the material treated. A fumigant does not affect the grain, but must possess good powers of penetration, be non-inflammable and be without harmful effect on the operators. It is essentially a chemical process and has been favoured all the world over. In the selection of a fumigant, the following conditions are essential. Primarily, the fumigant should be violenty toxic to insects only. It should be easily and cheaply generated and should not readily condense to a liquid medium. It should have great powers of diffusion and be insoluble in water as far as possible. The vaporization of the fumigant is the most important factor to render it thoroughly effective. The main cause of failure of fumigants is traceable to the sorption of the same either by the stored product or in the walls of

* This expression is employed to connote the removal of insects in general.

the fumigation chamber, whereby a large part of the vapour is rendered inactive. Hence ample allowance must be made for this sorption. What is sorbed by the foodgrain has little or no insecticidal effect. Therefore, the lethal concentration effect of the fumigant must be maintained after allowing for this factor. This aspect of the problem has recently been considered by many investigators. It is necessary to refer to the article of Oxley and Rowe[7] in this connection. Ordinarily, the atmospheric concentration around the insect is more important for practical purposes than the amount employed or taken by the insect. Thus according to Winteringham,[8] "in fumigation practice, the dosage of a fumigant required has often to be found by trial and error. Available data frequently express dosage in pounds per 1,000 c.ft. of chamber, which means that the dosage is based on the capacity of the chamber alone and does not allow for variation in the proportion of the fumigant sorbed by the product treated. This proportion is considerably affected by such factors as the nature of the product fumigated and temperature. The proportion of the fumigant sorbed by the product is sometimes very large. For example, during the fumigation of 140 lbs. bag of wheat feed with ethylenedichloride in a 500 L chamber, no less than 90 per cent. of the fumigant was sorbed by the wheat-feed, leaving only 10 per cent. available in the free air space for killing any infesting insects. The data obtained on the sorption of ethylenedichloride by various products have enabled dosage and distribution of the fumigant in the sorbed state to be estimated and have provided certain information about penetration, aeration and the nature of the residual fumigant". The higher the quantity of the fumigant sorbed by the feed, the larger the time needed for removing the same. Besides these, the successful fumigation of a product in practice, requires that (1) the bins or other containers employed must be capable of being closed tight; (2) the product must be warm enough, preferably at a temperature of 70-75° F. Better results are reported at 85-90° F.; (3) the bin doors must be sealed air-tight; (4) the fumigant should be applied by removing it from the original containers; (5) it is best to cover with a tarpaulin or with sacks, the surface of the product to be treated; and (6) the breathing of an excess quantity of the fumigant should be avoided. These are public health regulations requiring handling and manipulation by a technically trained staff. In this way alone, the hazards incidental to fumigation are minimised, if they could not be eliminated altogether.

Several fumigants have been in use. HCN gas or cyanides (6),* Carbontetrachloride ($^1/_{10}$), Carbonbisulphide (1), Ethyleneoxide (3-5½), Ethylenedichloride ($¼$-$^1/_3$), Chloropicrin (2½-3), Methyl Bromide (7), Methyl and ethyl formates (1¼), Trichloracetonitrile, have been recommended as fumigants. According to Shafik,[9] the order of toxicity of the fumigants together with minimum dosage (in c.c. per litre) for a 100 per cent. kill is as follows: Isopropyl chloracetate 0·008, Methyl chloracetate 0·01, Ethyl chloracetate 0·02, Ethylenedichloride and CCl_4 mixture 0·05, Ethylenedichloride and Trichlorethylene mixture 0·18, Ethyl formate and CCl_4 0·10, CS_2 and CCl_4 0·14, CCl_4 0·18, and Trichlorethylene 0·18. It will be seen from the above that a mixture of ethylenedichloride and carbon tetrachloride has been recommended and widely adopted. This mixture has all the good effects of an ideal fumigant mentioned above. The literature on fumigation is extensive and the following summary of the existing knowledge is included here.

The type of insects infesting grains is varied and includes moths, weevils, beetles, etc. Apart from this, we have to deal in each case, with the eggs, pupæ, larvæ and adults. One encounters in infested grains, at one and the same time, insects at all stages of development. Hence the fumigant employed must be effective equally on all the stages—which is unfortunately not the case. The action of fumigants on insect varieties also varies as can be seen in the following table:—

Median lethal conc. of fumigants for the confused flour beetle and the grain weevils:

Temp. 25° C. Time of exposure 5 hrs.

Fumigant	*T. confusum* (Flour beetle)	*S. granarius* (Granary weevil)	*S. oryzæ* (Rice weevil)
Hydrocyanic acid (HCN) ..	0·6	5·8	-
Chloropicrin	4·6	5·0	2·0
Methyl Bromide ..	11·2	7·6	4·0
Ethylene oxide ..	18·0	5·6	5·7
Methyl formate ..	23·5	20·0	—
Ethyl formate ..	24·5	25·0	17·5
Ethylene dichlinde ..	37·5	38·0	31·0
Carbonbisulphide ..	61·0	40·0	26·0
Ethylacetate ..	83·0	86·0	49·0
Trichlorethylene ..	108·0	335·0	196·0
Carbontetrachloride ..	185·0	360·0	160·0

(Expressed in mgs./L to effect 50% mortality)

From the data presented above, it is obvious that the toxicity of a fumigant varies in quantity from one kind of insect to another. The granary weevil is more resistant to fumigants in general than the rice weevil. These figures were obtained with commercial fumigants and are only relative. According to Shepard *et al.*,[10] two closely related species like *S. granarius* and *S. oryzæ*, are likely to "show the same relationship of toxicities throughout a considerable series of unrelated compounds."

Even in the same insect, the egg stage is commonly believed to be more resistant to a fumigant than other stages. Also a particular insect stage may be more resistant to some fumigant than to others. There is, however, no correlation between the respiration rate of insects at particular stages and a fumigant as is commonly thought.

* The figures in brackets refer to dosage needed on the basis of carbondisulphide as one unit according to an Australian worker.

Median lethal conc. of certain fumigants on different stages of the flour beetle. Temp. 25°C.

Fumigant	Egg	Larva	Pupa	Adult	
				Young	Old
Carbonbisulphide	147	60	136	110	63
Chloropicrin	45	3·5	9·1	4·3	4·4
Ethylene oxide	2	11·0	19·5	—	18·0

Here the adults are killed at about half the dosage of CS_2 or about $^1/_{10}$ the dosage of chloropicrin needed to kill the eggs, but they are 9 times as resistant as the eggs to ethylene oxide. Thus the fumigant effective against adults or larvæ may not be useful for killing the eggs. Also, the egg stage of certain insects may be more resistant to some poisons yet less so to others.

Further, geographical location is a factor operating likewise on insects, according to Lindgren and Shepard.[11] Apart from this, each stage of the insect differs in susceptibility at different periods of development. These specific differences in susceptibility to a fumigant are normally due to the differences in fatal dose but it is also possible that one species of insect may sorb more fumigant from a low concentration, while a second one may sorb from a higher concentration. Thus, rice weevils relatively resistant to HCN sorb only 0·444 mg. per gram of body-weight from a conc. of 77 mgs. in 10 mins. The question, therefore, is one of ready sorption of the toxic fumigant by a species of insects.

In recommending this method of treating infested grains, greater consideration must be given to hazards arising from the use of such toxic chemicals. Primarily, the human skin absorbs almost all the chemicals as shown by McCord.[12] It is also pertinent here to refer to the work of Wirtshafter and Schwartz,[13] reporting acute ethylenedichloride poisoning. It is, however, possible to overcome fire hazards in a suitable manner, such as diluting the fumigant with a noninflammable material like CCl_4. But the more important fact is the "residual" effect or sorption of the fumigant by grains and other food products. It is well known that only a certain quantity of the fumigant can exist as vapour without exerting pressure on the walls of a chamber or bin. In order that a fumigant may act on the insect, the atmospheric concentration around the insect is more important than the amount taken by the insect itself. Humidity also plays a large part in this. The sorption of a fumigant is about eight times that without flour or other absorptive material. It may be roughly stated that the higher boiling fumigants are most highly sorbed.

Where the fumigant is sorbed both by the stored product and by the insect in large amounts, the quantity of the fumigant necessary to maintain the lethal concentration in the air around the insect will be much more than what has been reported till now. This point has been stressed by Oxley and Rowe

Sorption ratios for various fumigants in presence of flour (Temp. 25° C.)

Fumigant	Lethal Concentration in mg./L		Sorption Ratio	B.P. °C.	Vapour pressure mm. 25° C.
	No sorbent	Flour			
Methyl bromide	10·2	21	2	4·5	760
Ethylene oxide	15·5	96	6	11·0	760
Hydrocyanic acid	—	—	2	26·0	739
Methyl formate	18	78	4	32	—
Carbon disulphide	64	147	2·5	46	361
Ethylene dichloride	46	240	5	84	80
Chloropicrin	3·9	35·5	9	112	24
Tetrachlorethylene	54	440	8	120	—
Methyl thiocyanate	1·4	16	10	130	—

(*loc. cit.*). According to Winteringham, in a bag of 140 lbs. wheat, to secure a final concentration of 62 mg./L of ethylene chloride in the free space, 455 grams of the fumigant for a 500 L chamber were needed for an exposure of 48 hours at 20° C. Similarly, for a bag of 100 lbs. in order to maintain a conc. of 36 mg./L, 58·5 gms. of the same fumigant were required. The conditions influencing the sorption of a fumigant also vary. Thus the lower moisture content of the grain, the less is the sorption of the fumigant. The quantity of ethylenedichloride sorbed by one variety of wheat is reproduced as read from the graph of the paper by Winteringham (*loc. cit.*).

Sorption of Ethylenedichloride (p.p.m.)

Conc. of the fumigant	Time in hours		
	24	48	168
10 mg./L	150	200	250
100 mg./L	1750	2000	2600
200 mg./L	3600	4000	5600

The only advantage in using ethylenedichloride mixture is, in the opinion of Shafik,[7] that it could be used safely for fumigating materials with a high water content, *i.e.*, in a heavily infested condition, or "in places where free water content cannot be excluded". In the opinion of others, "these mixtures are, however, unstable and not satisfactory". They are all fat solvents and so are not suitable for fatty materials.

p-Dichlorobenzene is a good seed disinfectant but it leaves a taint in the grain which does not, however, affect germination.

In fumigation practice, it is safe to provide gas masks for the workmen. First Aid provisions must normally be available.

Protective Coating with Insecticidal Dusts

The employment of protective dusts for storing grains free from insect pests is an agelong practice in various countries. Slaked lime has been used to the extent of even 5 per cent.

on the quantity of foodgrains. Chalk powder at the rate of 1 per cent. by weight, has also been used. Very fine dry soil has served more effectively in India and other countries. The protection afforded in many cases may merely be mechanical, in that the grain is covered and hidden from attack. The interest in the use of dusts has recently been aroused by the application of a large number of "inert" dusts including magnesia, silica as mentioned by Peters.[14] The availability of finely ground quartz, as a proprietary product "Naaki" aroused further interest in England and other countries. Zacher[15] suggested that the dusts acted on the insects as a desiccant. Chiu[16] reported the action of silica on the bean weevil in relation to particle size. These dusts have no effect on the physiology of the insect such as clogging the spiracles. But all the insects were found to clean their bodies vigorously with legs, mouth-parts and antennæ. If the killing of the insects was a desiccation process, it is natural to suppose that they would be most effective at low humidities. This was shown to be the case, by Germar. In his experiments, a mortality of 100 per cent. of the granary weevils was observed in two days at a R.H. of 20 per cent.; in three days at 45 per cent. R.H., in seven days at a R.H. of 80 per cent., while at 100 per cent R.H., it took 22 days for the insects to be killed. The temperature was 25° C. Apart from mere desiccation, the action of the dusts may be due to an irritation of the intestines. In Egypt, a product known as "Kattelsousse" prepared from ground rock-phosphate and sulphur has been sold by the I.C.I. on behalf of the Egyptian Government. This material has been used at 1 per cent. on the weight of the grain. Narasimhan and Krishnamurti[17] reported the use of scorched paddy husk for the same purpose. The ground husk was passed through 100-mesh and has been effective in controlling the insects.

In the last three years, considerable advance has been made in respect of the use of these dusts. Briscoe and co-workers[18] from the Imperial College of Science and investigators such as Parkin[19] from the Pest Infestation Laboratory, have tried to explain the various factors such as particle size, method of preparing the powders from different sources. The efficacy of a mineral dust may be correlated with the particle size secured from hard substances ground in the wet condition or in a micronizer, approaching that of colloidality and retaining simultaneously the microcrystalline or angular surfaces, which are lost by dry grinding. They have used the powder at 1 per cent. on the weight of the foodgrain but a lower percentage is possible. Less hard materials like gas-mask charcoal have also been successfully used in their studies.

As for raw materials, they select one with a hardness of over 6, on the Moh's scale, i.e., harder than Pyrex glass. Carborundum is available in England and has been widely experimented with. It is costly. The cheapest material has been featured from power-house clinker fired by mechanical stokers. Feldspar is equally good. Silica in any form has to be discarded, being a source of silicosis. The search for cheap substitutes like paddy husk ash (?), has been successful, but it may not be quite well known that the scorched husk contains over 90 per cent. of the ash, as *free* silica. Railway clinker and similar materials had been tried by the writer successfully.

The most important factor in this project, is the size of particles of the powders used to coat the grains. The finer the particles, the greater is their adhesion to the grains and insects. It has been ascertained that a particle size above 20 μ does not stick to the grains. When the particles are about 1 μ, agglomeration of the same takes place, although adhesion is maximum. Such powders, when employed at 1 per cent. basis, give a very thick coating both on the grains and on insects. Chiu[16] correlated the action of crystalline silica against been weevils as follows:—

Diameter of particles in microns		Days required to kill	
Range	Average	50%	100%
1—147	2·9	1·8	5·0
1—149	18·8	4·2	10·0
10–74	37·5	10·5	18·0
74–149	111·0	14·5	20·0

It may be pointed out here that particles above 20 μ are not considered effective. The maximum effect has been observed with a particle of 1·8-2 μ. In practice, particles ranging from below 15 μ are quite adequate for general use. In one of the trials, the distribution of particles in a carborundum powder has been reported as follows:—

under 1 μ	0·1%	between 5-7 μ	32·0%
1-3 μ	10·0%	7-9 μ	21·0%
3-5 μ	29·0%	Over 9 μ	8·0%

The distribution of particles in a given powder must be estimated by established methods such as those of Goodhouse.[20] But it must be cautioned here that "size classification by sedimentation in water is usually undesirable." The production of such fine powder is easily effected in commercial ball mills. The method of grinding influences largely the effect of the dust. While dry grinding may be quick and yield very fine powders, it had been ascertained that such powders had not the same effect as those ground wet. In grinding, the nature of the liquid is immaterial. This difference between dry and wet grinding is large in the case of clinkers, quartz, magnesite, etc. Where dry grinding has been effected, it was observed that treatment with hydrofluoric acid improved the effect of the dusts. Where the same could be secured in the precipitated condition, the activity was quite efficient. One of the most important aspects of the dusts treatment is that the powder intended for use must be kept dry, although it does not absorb water. The effect on the insect is one of desiccation without itself absorbing any water. Dusts differing greatly in chemical composition, but of similar composition show comparable effectiveness.

The influence of R.H. on the dusted grain is an important aspect. Thus at 100 per cent,

R.H. the mortality was hardly 1½ times that of the control, while at 90 per cent. R.H., this activity rose to three times that of the controls. The work of Germar had already been referred to earlier.

In summarising the above, it may be mentioned that the process of coating grains with dusts is a simple one and consists merely in the mixing of the same with a definite quantity of the fine powder in a suitable equipment. This method can be used both for cereals and pulses. The general opinion in respect of eliminating the dusts, prior to milling, etc., is that it presents no difficulty. Moreover, many of the dusts are innocuous to the alimentary tract. The treated grain may be stored in closed containers so as to avoid exposure to atmosphere and to changes of weather. The coating of grains with dusts to control insects in stored products is, therefore, recommended for the following reasons. In the first place, it protects healthy grains from insect invasion. Secondly, the infested grains containing both the adults and larvæ are rapidly freed of these destructive agencies being desiccated and finally killed by the dusts. It may be mentioned here that the age of the insects is a factor, the young larvæ being more susceptible than the adults. The treatment is effective with regard to the existing population, in retarding oviposition and hence prevents reinfestation. The pupæ emerging from the eggs are rapidly killed by the dusts. Thirdly, the ray materials for these dusts are plentiful and the choice is very wide for selection for cheapness. None of them need be imported from abroad, as is the case with fumigants. The example of Egypt is worth emulating in this respect. The equipment for the production of such fine powders can be rigged up in each province, the same being very simple in character and construction. There is no harm introduced by these dusts, as is probable with fumigants. Finally, the process is economically practicable from the view-point of cost and ease of application.

The quality of the grain so treated is in no way affected. Only the treated grain does not flow as readily as the dry fresh grain, but this is no serious defect if it is remembered that the highly infested grain does not also flow readily.

A Practical Method for Treating Grains to Store Them

The following suggestions are thus made for practical adoption. The grain as received, is first sieved in a vibrating screen, whereby the adult insects are removed. Where the infestation is heavy, such grains may first be passed through a screw conveyor fixed in a jacketed galvanised iron trough, heated in a suitable manner. In this way, the dehydration of the grain is also effected. This is then screened. The clean grain is next mixed with the dust, which may vary from 0·3 to 1 per cent. on the weight of the grain depending upon the efficiency of the dust selected. The mixing may be done in drums, in various places, prior to storage in bins or granaries or other containers which may be capable of being closed fairly airtight. Such containers can also be of plaited bamboo, earthen structure, cement concrete and the like. These containers should be protected from destruction by rats. For this purpose, these are raised more than 3 feet high from the ground, standing on legs which are provided with 4-inch iron-sheets protruding outside alround the bottom.

The author had been interested recently in the processing of a cheap clinker and a non-siliceous material and could supply adequate quantities on demand.

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PITHECANTHROPUS IN PEKING

IN reviewing the work of Weidenreich on *Sinanthropus*, Prof. W. E. Le Gros Clark seeks to establish that there is no justification for a separate genus *Sinanthropus* (*Antiquity*, XIX, 73). In this view, he is supported by Prof. Ruggles Gates who holds that *Sinanthropus pekinensis* should, according to the rules of biological nomenclature be called *Pithecanthropus pekinensis*. *Pithecanthropus* and *Sinanthropus* are related to each other in the same way as two different races of present mankind. The Java Man possessed essentially human palate and dentition and also quite human limbs and erect gait. From this probably arose the generalised Neanderthaloid type, which diverged in two directions, one of which led to the specialised European Neanderthal type of the later Mousterian date, and the second through Acheulean man to *Homo sapiens*.

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QUANTUM MECHANICAL THEORY OF THE JOSHI EFFECT

THIS phenomenon,[1,2] *viz.*, the suppression of conductivity on irradiation of chlorine and some other gases has been interpreted recently by Prasad[3] from the standpoint of Kramers' quantum mechanical theory of light dispersion. It is considered that consequent on irradiation the gas is excited to higher vibrational and electronic states. For these, due to the operation of negative terms in the Kramers' dispersion formula, the refractive index n decreases below that for the normal gas. Applying Maxwell's well-known relation, $n^2 = k$, where k is the dielectric constant, it follows that k should diminish. Since k is a measure of the electro-static capacity of the system, Prasad[3] considers that the light-effect as defined by Joshi,[2] represents a decrease of the displacement current as distinct from the conductance or ohmic current. Prasad[3] arrives at the same consequence from analogy between the excited and isolated states of a gas; for the latter k is known to be smaller than normal.

The validity of the above deduction was tested experimentally. Alternating electric fields of frequencies f veried in the range 5 to 10 mega-cycles per second, generated by a Hartley type valve oscillator were applied across the annular space of a Siemens' ozoniser, filled with pure chlorine. V, the P.D. across the ozoniser was measured by a thermionic valve voltmeter and the corresponding current with a *low resistance* Cambridge vacuo-junction connected to a sensitive mirror galvanometer. In an observation, typical of several series of results, at a given input to the system the current produced a steady deflection of 315 units. No detectable change ($> 0{\cdot}5$ unit) occurred on irradiating the system with (i) a 500 candle power (glass) bulb, (ii) a large-size quartz mercury vapour lamp and (iii) when both the light sources were used simultaneously. A decrease of the above current which, according to Prasad,[3] is of the dielectric or displacement type, should have occurred, since ordinarily, this light-effect is quite considerable, and under optimum conditions as high as 93 per cent.[4]

Series of experiments were next made in which the discharge current in the above range were obtained by exciting the ozoniser at large V and low f. When, for example, the above current deflection was produced at $V = 10{\cdot}7$ kV, $f = 50$ cycles per second and the ozoniser was irradiated by any of the above-mentioned light-sources, an instantaneous and reversible *light-effect* in the range 19 to 27 per cent. was produced.

It would appear that as suggested by Prof. Joshi[2] an explanation of this phenomenon might, in the first instance, be sought, (i) in a possible decrease of the average ionic velocity and intensity of ionisation, (ii) increased recombination of the opposite ions and (iii) a decrease in the number of the

metastable (and excited) atoms and molecules, produced under irradiation. An important general result established by Prof. Joshi over a wide range of conditions, is that this phenomenon does not occur at potentials less than V_m,[1,5] 'the minimum threshold potential' when the gas breaks down as a dielectric.[5] In fact, it was from the observation by Prof. Joshi of a photo-increase of V_m[1] that (arguing from the finding that the current depends upon $V - V_m$[6]), he predicted that the corresponding current should decrease under light. Whatever be the actual mechanism of this phenomenon, it has significance for the current theories of photo-electric action and represents a hitherto unrecognised factor in conduction under electrical discharge.

Chemistry Department,
Benares Hindu University, G. S. TIWARI.
June 20, 1945. B. N. PRASAD.

1. Joshi, (*a*) *Curr. Sci.*, 1939, **8**, 548; (*b*) *Ibid.*, 1944, **13**, 253; (*c*) *Ibid.*, 1945, **14**, 67. 2. —, *Pres. Address, Chem. Sec., Ind. Sci. Cong.* 1943. 3. Prasad, *Nature*, 1944, **155**, 362; *cf.* also Kroff, *Rev. Mod. Phys.*, 1932, **4**, 471; Ladenburg, *Ibid.*, 1833, **5**, 343. 4. Joshi and Deo, *Nature*, 1944 **153**, 434. 5. Joshi, *Ibid.*, 1944, **154**, 147. 6. Joshi, *Trans. Farad. Soc.*, 1929, **25**, 120.

THE BANDS OF PO MOLECULE

A VIBRATIONAL quantum analysis of the bands of phosphorous monoxide in the region λ 2600 has been published by Ghosh and Ball[1] and a rotational analysis of some bands of this system has been given by Sen Gupta.[2] The bands are shown to be due to $^2\Sigma \rightarrow {}^2\pi$ transition. Besides this system, the PO molecule is well known to give rise to other characteristic groups of bands in the region λ 3300. The vibrational analysis of these bands does not appear to have been published so far. In the course of investigations, in this Laboratory, on the P_α bands[3] excited under different conditions, the above-mentioned bands of the PO molecule have been obtained. These bands are found to be strongly emitted in a wide open heavy current arc between carbon poles containing phosphorous pentoxide. Some of the bands are degraded to the red and some to the violet. Several attempts to include all the bands into one system having failed, the red degraded bands are analysed into one vibrational system and the violet degraded bands into another system. The two systems have presumably a common final level $^2\pi$ identical with the ground state of the ultraviolet system.

The following vibrational constants for the two systems are obtained.

Violet degraded system	Red degraded system
$\nu_e = 30606{\cdot}5$	$\nu_e = 30260{\cdot}8$
$\omega'_e = 1151{\cdot}9$	$\omega'_e = 1094$
$x'_e\omega'_e = 14{\cdot}19$	$x'_e\omega'_e = 14{\cdot}5$
$\omega''_e = 1223{\cdot}9$	$\omega''_e = 1234$
$x''_e\omega''_e = 6{\cdot}46$	$x''_e\omega''_e = 9{\cdot}5$

A detailed account of the work will be published elsewhere.

R. RAMANADHAM.
G. V. S. RAMACHANDRA RAO.
Andhra University,
Guntur,
June 20, 1945.

1. Ghosh and Ball, *Zeits. f. Phy.*, 1931, **71**, 362. 2. Sen Gupta, *Proc. Phy. Soc.*, (Lond.), 1935, **47**, 247. 3. Narahari Rao, K, *Ind. Jour. Phy.*, 1943, **17**, 135 and 149.

ON THE ULTRA-VIOLET BANDS OF K

BESIDES the three systems of K_2 in the infrared and visible regions studied by a number of workers, Yoshinaga[1] measured about 110 band heads in absorption between λ 4160 and λ 3480 A. and arranged them into five different systems, all arising on account of transitions from the $^1\Sigma_g$ ground state to different upper states. The only data at wave-lengths below λ 3480 A. are due to Chakraborty,[2] who noted some bands of K_2 accompanying each member of the principal series line of potassium. Since he worked with an instrument of high dispersion, only few bands could be recorded in his spectrogram.

While working with an Intermediate quartz spectrograph, a large number of bands, not reported earlier between wave-lengths 3690 and 2920 A., has been noted in the present case. Of these, the bands between λ 3200 and λ 3100 A. are much better developed than those lying in the rest of the region. The experimental arrangement consists of an iron tube heated by an electric current flowing through a nichrome wire wound round an asbestos covering over the tube. The ends were closed by quartz windows and were water-cooled. Light from a hydrogen continuum was passed through potassium vapour obtained by heating a purified sample of the metal kept in an auxiliary iron cell inside the furnace tube and analysed by an Intermediate quartz spectrograph. Spectrograms were taken at several temperatures and pressures, the value of the latter being regulated by introducing dry nitrogn gas from a cylinder. The bands given in the table below (being more intense than those appearing in the rest of the region) were obtained at 700° C. when the pressure inside the furnace as read by a mercury manometer was 30 cm. The intensities were estimated from a micro-photogram of the spectrum.

ν cm.$^{-1}$ vac.	v''–v'	Int.	ν cm.$^{-1}$ vac.	v''–v'	Int.
31115	10–4	2	31467	5–2	1
31163	10–5	4	31517	5–3	2
31212	9–4	4	31557	4–2	2
31251	8–3	4	31606	4–3	2
31290	7–2	2	31679	2–1	1
31339	7–3	2	31726	1–0	1
31388	7–4	4	31818	0–0	1
31428	6–3	1	31868	0–1	1

The above bands can be represented by

$$31818 + 51v' - \cdot 5v'^2 - 92v'' + \cdot 3v''^2.$$

The agreement between the values of w_0'' and $x_0'' w_0''$ with those given by others is reasonably good.

Further work is in progress to classify the bands at wave-lengths both higher and lower than those given in the above table.

My thanks are due to Prof. D. K. Bhattacharya and to Prof. S. P. Prasad for their kind help and encouragement in doing this work.

Physics Laboratory,
Science College, S. P. SINHA.
Patna,
June 23, 1945.

1. *Phys. Math. Soc. Proc. Japan*, 1932, **19**, 847.
2. *Indian J. Phys.*, 936, **10**, 155.

A POSSIBLE "TERRESTRIAL EFFECT" IN THE ATMOSPHERIC OXYGEN SPECTRUM

IN a previous communication to this *Journal*[1] the author pointed out that if we were to accept, generally, current theories of the origin of the earth's magnetism and electricity, and of the internal geophysical structure, then it must follow that there exists an exceedingly strong electric field at the surface of the earth's internal core, and a variable charge in the uppermost atmosphere, as a result of which the electric potential of the earth's surface was not a fixed quantity, but that it varied over a wide range of values. Further, we should have to consider the terrestrial electric field system as being made up of three distinct components (1) the electric field at the surface of the internal spherical core (whose radius is 3,500 km.) of the order of 6×10^8 volts per cm.[2]; (2) the intermediate electric field within the crust or shell of thickness 2,900 km. indicated by the entrance at the under-surface of the crust of thermoelectrons and negative ions, and by the exit at the upper surface of air-earth current electrons and negative ions; and (3) the electric field at the earth's surface which owed its existence and magnitude also to the variable charge in the upper atmosphere.

Since the three are causally interdependent and spherically concentric, it must follow that the field as registered by an electrograph at the earth's surface must represent in magnitude, the resultant arising from all the three components, and we should be justified in representing the combined system for simplicity, as having a magnitude of 6×10^8 volts per cm. (or about 10^{11} volts per metre) at the core's surface, a value of 10^2 volts per metre at the earth's surface, and a negligibly small value at the lowermost levels of the upper atmosphere. The following relationship will be found to satisfy these values:

$$y = 10^{11}e^{-\cdot 0075\ x}$$

where y is the strength in volts per metre at any point in the composite field system at a height of x km. from the core's surface[3]; and integrating the expression between the values $x = 0$ and $x = 2{,}900$ km. (thickness of the crust), would now give us an approximate measure of the electric potential of the earth's surface with respect to the core, on a basis of 100 volts per metre as the recorded atmospheric field. It is of the order of 10^{13} volts. Should the atmospheric field be doubled or quadrupled, as it does in its usual course for example, the combined electric field throughout would be doubled or quadrupled, as also the potential of the earth's surface by a factor of 10^{13} volts. In other words, for every 100 volts per metre change in the recorded field, the electric potential energy of the earth's surface and of every molecule on it, would undergo a change of 10^{13} volts. And this would be identical with the action of an equivalent, hypothetical, applied, uniform, electric field at the earth's surface of the order of 10^{13} divided by 10^9 cm. (radius of the earth), or 10^4 volts per cm. acting on the molecule.

It would be interesting to investigate the possible spectroscopic implications of such an effect on molecules at the earth's surface. Changes in the potential energy of a molecule brought about by a strong applied, uniform, electric field are accompanied, in the main,[4] by a proportional shift in the position of the band lines, and a corresponding change in spectral intensity. It is, hence, significant that Perot[5] detected a diurnal change in wavelengths in the A band of atmospheric oxygen which he did not account for adequately but which, on examination, will be found to coincide with diurnal changes in the magnitude of the universal component of the earth's electric field, namely, a secondary maximum of field strength at dawn corresponding to a maximum spectral frequency, a primary minimum around mid-day, and a primary maximum towards midnight. There is also a secondary minimum in field strength at about 4 a.m. by Indian standard time. In regard to intensity, the author found, particularly in the region of the atmospheric spectrum in which the oxygen bands predominate (the red), that intensity variations followed remarkably closely on changes in the atmospheric potential gradient at night,[6] and that these could not possibly be attributed either to atmospheric pollution or to any possible changes in the night sky light which was used as a background source in the course of the observations. Action by an electric field on the oxygen molecule is thus strongly suggested.

While quantitative work on verification of these findings is, at present, unfortunately held up for want of suitable equipment, it is important to note for the guidance of other workers, that the use of the solar spectrum and the usual interferometric methods[7] are liable to offset the effect under certain conditions, and that the most suitable means would seem to be the use, on a *clear* night, of a powerful source of artificial light, with an air path of several kilometers, for it is during the night that the earth's electric field undergoes its most striking changes. A series of half-hourly exposures during the same night should be recorded on one photographic plate, and corresponding changes in intensity and spectral location noted carefully.

I wish to thank Prof. N. R. Tawde of the Royal Institute of Science, Bombay, for many valuable suggestions during these investigations.

Colaba Observatory,
Bombay, ALFRED B. ARLICK.
June 30, 1945.

1. Arlick, A. B., *Curr. Sci.*, 1945, **14**, 151. 2. *Cf.* Prof. W. F. G. Swann's concise mathematical treatise "Terrestrial Magnetism: Theories of Permanent Magnetisation," *Encycl. Brit.*, 1943, **21**, 965 3. In reality the dielectric constant of the field medium traversed would have to be taken into consideration but, as we shall be dealing only with *relative* change, this omission need not mar the conclusions arrived at. 4. MacDonald, J. K. L., *Proc. Roy. Soc.*, 1932, **138**, 183-202. See also the other relevant references noted in that paper. 5. Perot, A., *Comptes Rendus*, 1915, **160**, 549. 6. Arlick, A. B., *Science and Culture*, 1939, **5**, 62. 7. Babcock, H. D., and John, S., *Astrophys J.*, 1922, **55**, 46.

In a subsequent paper Babcock maintains that with a spectrograph of high resolving power, only 3 metres of air path need suffice.

ON THE ANALOGY BETWEEN THE POSITIVE LICHTENBERG FIGURE AND THE SPLASH OF A DROP OF LIQUID

AN interesting article by John Zeleny on the variation of the size and charge of positive Lichtenberg figures with voltage has appeared in the April 1945 issue of the *American Journal of Physics*. The present writer was much impressed by the similarity of the curves obtained by Zeleny showing the variations of the diameter of the positive Lichtenberg figures with charge and voltage, to the curves obtained by the writer showing the variations of the diameter of the splashes produced by drops of liquids of various masses and falling through various heights.

The curves showing the variation of the diameter of the Lichtenberg figure with voltage is again similar to the corresponding curve obtained by the writer showing the variation of the diameter of the splash produced by a drop of water of definite mass falling through various heights. In the latter case, however, the water drop attains a terminal velocity after falling through a certain height and the diameter of the splash remains constant after this height of fall.

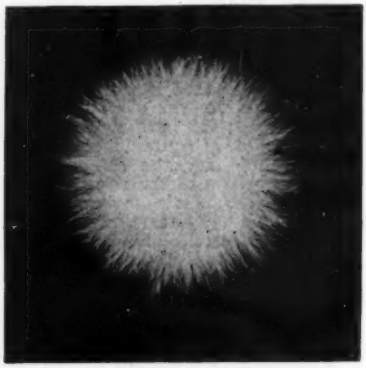


FIG. I (*a*)
Positive Lichtenberg Figure

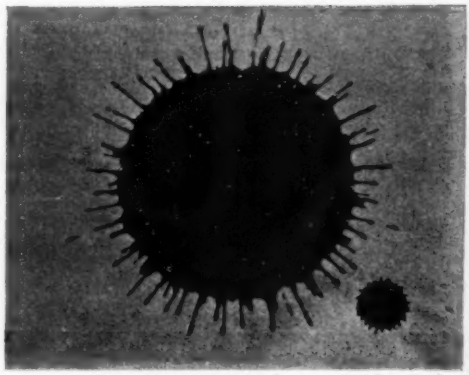


FIG. I (*b*)
Splash of a drop

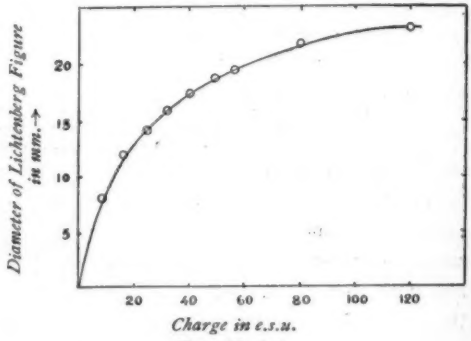


FIG. II (*a*)

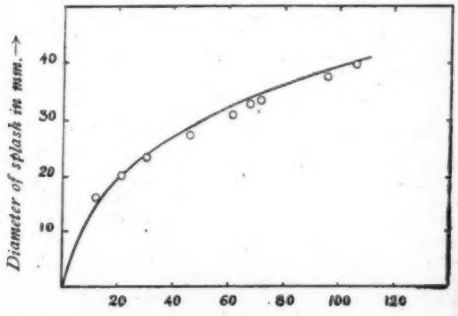


FIG. II (*b*)

This close similarity is no doubt due to the essential dynamical similarity of the two processes. The charge of the Lichtenberg figure corresponds to the mass of the liquid drop and the voltage corresponds to the height of fall of the liquid drop. Both processes are almost instantaneous. The Lichtenberg figure may, therefore, be regarded as a splash produced by a drop of electricity.

The Lichtenberg figure is obtained only on insulators like glass, ebonite, etc. On a good conductor the electricity immediately spreads. However, for different substances the diameters of the Lichtenberg figures are different.

In the corresponding case of the splash of the liquid drop, the diameter of the splash varies with the absorbing properties of the material on which it is produced. If any absorbent paper like filter-paper is used, the diameter of the splash is increased. This suggests that a good conductor acts like an infinite absorber of the electric charge and produces as it were a Lichtenberg figure having the size and shape of the conductor itself.

The analogy cannot obviously be pushed too far, but as far as it goes, it is interesting enough.

Department of Physics,
Nowrosjee Wadia College,
Poona, V. N. KELKAR.
August 10, 1945.

PARACHORS AND MOLECULAR DIMENSIONS

AN equation to calculate molecular diameters in the liquid state from parachors has been already proposed by the author.[1] In the case of gaseous substances, molecular dimensions can be calculated by correlating the Van der Waals constant $b=\frac{V_c}{3}$ with parachor in the following manner. According to Sugden,[2] the mean value of $\frac{[P]}{V_c}=0{\cdot}77$, where [P] and V_c are the parachor and critical volume respectively. Hence we get $b=\frac{[P]}{2{\cdot}31}$. If molecules are assumed to be spherical in shape and if a substance is regarded as an assemblage of spheres of diameter σ packed together as closely as possible,[3] it has been calculated that $b=\frac{1}{4}\ \pi\sigma^3 N$, where N is the Avogadro constant. Thus,

$$\sigma=0{\cdot}7\ [P]^{\frac{1}{3}}\times10^{-8}\ \text{cm.} \qquad \text{(i)}$$

The reliability of the ratio $\frac{[P]}{V_c}=0{\cdot}77$ has now been determined by Herzog[4] to be of the order of $\pm$ 30%. Allowing a maximum deviation of $\pm$ 30% for this ratio, the reliability for σ will be of the order of $\pm$ 10%, since the above equation for calculating σ from [P] involves a cube-root of [P]. Calculations of molecular dimensions from parachors can be of great use in the study of chemical kinetics of reactions, since parachor data are more readily available than other data required to calculate molecular diameters.

If more reliable calculations are desired, the following method may be adopted. A dimensional analysis of the parachor gives the equation[5] $[P]=KV_c^{5/6}\ T_c^{1/4}$, the value of $K=0{\cdot}41$ being proposed by Ferguson.[6] Rewriting,

$$V_c=2{\cdot}92\frac{[P]^{1{\cdot}2}}{T_c^{0{\cdot}3}}.$$

Substituting for V_c by $3b$ and for b as in (i), we get

$$2n\sigma^3N=2{\cdot}92\frac{[P]^{1{\cdot}2}}{T_c^{0{\cdot}3}}.$$

Hence

$$\sigma=0{\cdot}92\frac{[P]^{0{\cdot}4}}{T_c^{0{\cdot}3}}\times10^{-8}\ \text{cm.} \qquad \text{(ii)}$$

Equation (ii) has a reliability of about $\pm$2·2% for all compounds excepting the following:—those having the functional groups $-C=0$, $-C\equiv N$, $-$ COOH, and $-$ OH, and one to three additional non-functional carbons.[4] For such substances, the following equation

$$\sigma=0{\cdot}96\frac{[P]^{0{\cdot}4}}{T_c^{0{\cdot}1}}\times10^{-8}\ \text{cm.}$$

holds good with a reliability of $\pm$ 3·5%.

Laxminarayan Institute of Technology,
Nagpur University,
Nagpur, M. S. TELANG.
May 15, 1945.

1. Telang, *Curr. Sci.*, 1943, **12**, 19–20. 2. Sugden, *J. Chem. Soc.*, 1924, **125**, 1177; "Parachor and Valency," Routledge, London, 1930, p. 31. 3. Jeans, "The Dynamical Theory of Gases," Cambridge University Press, 1925, p. 127. 4. Herzog, *Ind. Eng. Chem.*, [Ind. Ed.], 1944, **36**, 908. 5. Reilly and Rae, "Physico-Chemical Methods," 3rd ed., **1**., Methuen & Co., London, 1940, p. 110 6. Ferguson, *Nature*, 1930, **125**, 597.

POSITIVELY CHARGED FERRIC VANADATE SOL

IN a communication[1] from this laboratory, the preparation of negatively charged ferric vanadate sol was described. It is now observed in presence of glucose ferric chloride dissolves a considerable amount of ammonium vanadate, to give a red coloured sol which bears a positive charge. The sol under investigation was prepared by dissolving 40 c.c. of ammonium vanadate solution (corresponding to 6·49 gms. of V_2O_5 per litre). In 20 c.c. of ferric chloride solution (corresponding to 34·92 gms. of Fe_2O_3 per litre) in presence of 20 c.c. of 20 per cent. glucose solution. The sol. was kept in a parchment paper and was dialysed for two days.

Composition of the Sol.—The amount of iron and vanadium in a known volume of the sol were determined by the standard methods of analysis. The combined iron corresponding to this amount of vanadium was calculated on the assumption that the ferric vanadate is $FeVO_4$. The rest of the iron is present as hydrated ferric oxide. From the ratio of the free to the combined iron, the emperical formula of the sol can be suggested.

Per litre:
Total iron—5·5282 gms.
Combined vanadium (V_2O_5)—3·1832 gms.
Combined iron—1·9540 gms.
Free iron—3·5742 gms.
Viscosity of the sol (30° C.)—0·00864 gms.
Viscosity of water (30° C.)—0·00803 gms.
Water bound—0·3519 gms.
Empirical formula—9 Fe_2O_3.10 $FeVO_4$.6H_2O.

The amount of bound water per litre of the sol was calculated from the Hatschek's[2] equation expressed in the following form:

$$\text{Bound water per litre} = \frac{1000}{A} = 1000\left(\frac{\eta_t - \eta_w}{\eta_t}\right)^3$$

where A is the ratio of the total volume of water in the sol to the volume of the water bound, η_w is the viscosity of the water at 30°C. and η_t is the viscosity of the sol at the same temperature (*cf.* Prakash).[3]

Detailed procedure of the study of the sol will be published elsewhere.

I am indebted to Dr. Satya Prakash for his valuable guidance and advice.

Chemical Laboratories,
Allahabad University, S. P. MUSHRAN.
July 4, 1945.

1. Mushran, *Current Science*, 1945, **14**, 123. 2. Hatschek, *Kolloid. Z.*, 1911, **8**, 34. 3. Prakash, *Ibid.*, 1932, **60**, 184.

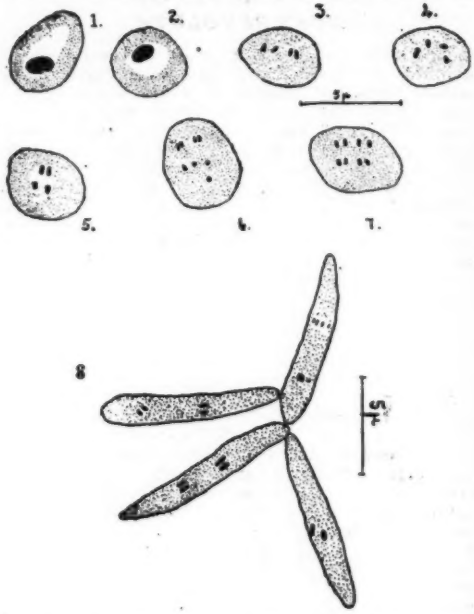
INDUCTION OF POLYPLOIDY IN *SACCHAROMYCES CEREVISIAE*

BAUCH[1,2] claims the production of new races of yeast by treatment with camphor and acenaphthene. Since these new races were bigger than the original strains he tentatively suggests that the chromosome numbers ought to have been doubled, tripled or quadrupled. However, no cytological confirmation seems to have been attempted. Since this line of attack offered interesting possibilities some experiments were conducted in this direction.

Sterile test-tubes of wort were inoculated with a loopful of Sc 9 (N.C.T.C. 3007) from a wort-agar slant and a few cyrstals of acenaphthene were added to the tubes. The time of treatment was arbitrarily fixed at 6 hours in order to have sufficient material for smearing. At the end of the above period the material in the tube was centrifuged and smears were made at definite intervals to get the mitotic figures. The slides were fixed in Carnoy and stained in Heidenhain's hæmatoxylin.

The pictures obtained were very interesting. Long thread-like mycelial growths are common, the cells measuring 9-10 μ in length and 1·5-2·0 μ in width (Fig. 8). Resting cells vary in dimensions from 3·5 μ to 5·5 μ and have a clear cytoplasm having a large vacuole and a stained nucleus (Figs. 1 and 2).

What strikes one is the large number of cells having four chromosomes disposed in various ways (Figs. 3, 4 and 5). Cells showing eight such chromosome-like structures are also common (Figs. 6 and 7). The measurements of the chromosomes are not given since the equipment at my disposal does not enable accurate measurements to be made. However, they appear to be far smaller than those



of the control strain (see Subramaniam and Ranganathan[3]). This disparity in the size of the chromosomes in different strains might have been the cause for the controversy concerning the identification of certain structures seen in the yeast cell during vegetative division, as the chromosomes (see Subramaniam and Ranganathan[4]).

What appears to be a tetraploid strain has been isolated by planting and this is now being purified. Uptill now all the cultures have been kept in the vegetative condition. Whether these strains would retain their chromosome constitution after repeated sporulation and whether they have any economic importance can only be judged after extensive tests.

I am very grateful to Sir J. C. Ghosh and Sri. M. Sreenivasaya for their active interest and encouragement, and to Messrs. The K. C. P., Ltd., Uyyuru, for the award of a Studentship.

Fermentation Technology Section,
Indian Institute of Science,
Bangalore, M. K. SUBRAMANIAM.
June 1, 1945.

1. Bauch, R., *Naturwissenschaften*, 1941, **29**, 503–504. 2. —, *Woch Brau*, 1941, **59**, 1–7; 9–11. 3. Subramaniam, M. K., and Ranganathan, B., *Curr. Sci.*, 1945, **14**, 78–79. 4. —, *Ibid.*, 1945, **14**, 131–132.

A NOTE ON THE ASSOCIATION OF *CHLOROCOCCUM HUMICOLUM* IN THE ROOTS OF *CYCAS REVOLUTA*

DURING the course of their investigations on the microbial flora associated with the nodules and root-forms of some non-leguminous plants, the work on *Cycas revoluta* was planned with a view to ascertain the synergetic action of all the biological entities present within the roots. Special attention was paid to the study of the well-known *Anabœna cycadœ*, an alga of ecological interest. For isolating this alga various media, including Beijerinck's basal ammonium nitrate solution, Benecke's solution and a new medium (nitrogen-free) devised by the authors, were tried.

It was observed that the coral roots of one of the many *Cycas revoluta* plants they had examined consistently gavè rise, in the new medium referred to above, to a new type of algal growth (which on examination for morphological features proved to be *Chlorococcus humicolum*) not hitherto recorded. It was also observed that the preliminary growth of this alga (which is presumably new for the roots of Cycas) appeared only after about three months of incubation at the room temperature (about 27° C.), whereas the sub-cultures of the same made evident its growth in the same medium within a brief period of fifteen days. It must also be mentioned in this connection that the algal growth was absolutely free from any other growth, microbial or otherwise.

The medium above referred to had the following composition:—

Water (distilled)—1,000 c.c.
Di-potassium-hydrogen phosphate—0·20 gm.
Potassium chloride—0·10 gm.
Calcium carbonate—0·10 gm.
Ferric chloride—0·10 gm.

A glance at the ingredients will at once reveal that it is a purely synthetic medium, and what is more striking, is that it contained no nitrogen in either organic or inorganic form.

As far as the present authors are aware, *Chlorococcum humicolum* has not been recorded to occur as an endophytic organism in the corolloid roots of Cycas, though it is a widely distributed algal species, occurring in a diversity of habitat such as damp soil, brick-work, etc.

This alga grows luxuriantly in both Beijerinck's and Benecke's media, yet the fact that satisfactory growth of the alga takes place in the nitrogen-free medium also, suggests that the alga can tolerate an absence of combined nitrogen and leads to the presumption that it is a nitrogen fixer. Its presence together with various other biological entities associated in the roots of Cycas points to the role of these organisms in the nitrogen metabolism of the plants in whose roots they occur. And the recent observations of Yoshimura amply support such a view.

The authors wish to thank (Mrs.) E. Gonsalves, of the Royal Institute of Science, for kindly verifying the identity of the new alga isolated.

Microbiology Department,
St. Xavier's College, F. FERNANDES.
Bombay, J. V. BHAT.
June 1945.

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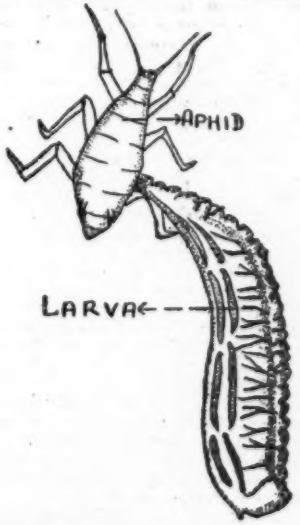
NOTES ON A SYRPHID (*SPHAEROPHORIA SCUTELLARIS* FAB.) FLY PREDATOR ON MUSTARD-APHID (*RHOPALOSIPHUM PSEUDOBRASSICAE* DAVIS)

DURING the course of my study of biology of the mustard-aphid, *Rhopalosiphum pseudobrassicæ*, syrphid-fly larvæ were observed among the aphids. It was rare to find any colony of the aphids that did not have from one to many elongate larvæ preying upon them. Hidden among the aphids, these larvæ (Fig. 1) grasp aphid after aphid by their pointed jaws, raise it in the air, slowly pick out and suck out all the body contents, finally discarding the



empty skin. It has been observed that sometimes a larva destroys aphids at the rate of one every minute and this process continues for a considerable period. In fact, the rate of

destruction depends on the age of both the larvæ and the aphid, i.e., a full-developed larva can destroy larger number of aphids of younger ages. It has also been observed that the larva attacks not only apterous aphids but can attack and destroy even the winged aphids when they come within its reach. The predator appears to be of a very great importance, and, therefore, a short account of it is given here.

Egg.—The eggs are laid by the adult fly among the aphid-colony. The eggs are pearl-white and more or less elliptical in shape with gently rounded ends. The anterior end is somewhat flattened, it is the place where opening is formed at the time of hatching of the egg. The egg-surface is covered with longitudinal ridges which are connected with one another through transverse ridges and thus a number of quadrangular areas are formed all over the egg-surface. The egg is about 0·9 mm. long and about 0·4 mm. thick.

Larva.—The full-grown larva is slender, with the ventral aspect flattened and the body much attenuated anteriorly. The cuticle is tough and leathery and greenish or brownish. The segmentation is more or less obscure owing to the transverse corrugation of the body. However, a closer study shows that there are eleven segments. The general appearance is rather slug-like. The technical system is of amphipneustic type, i.e., only the prothoracic and the posterior abdominal spiracles are open. The anterior spiracles are on the second apparent segment, while the posterior pair is situated on two tubes which are very short and are fused together down the median line. From the sucker-like mouth located on the undersurface of the first segment, protrudes a pair of black-toothed hooks —the mandibles. These are supported by and connected to the cephalopharyngeal skeleton, which is a V-shaped structure extending back into the body as far as about the third segment. The cephalopharyngeal skeleton is a blackish scleritised structure and is usually visible through the integument of the larva. It differs in shape in different larval stages. In the first larval stage it is small and incompletely developed, while in the last larval stage it is completely developed and the parts are easily distinguishable. The full-grown larva is about 9 mm. long and about 2·5 mm. at the thickest place.

Pupa.—Prior to pupation the larvæ come to rest near their habitat, the caudal segments become cemented to the leaf or to the cage-wall with a black secretion apparently exuded from the hind gut. The pupa becomes again cemented if it is decemented. This shows that the secretion restarts when required. The pupa forms inside the last larval skin. The puparium is inflated dorsally and laterally. Spiracles are present on the puparium in the region of the fourth segment and are elevated upon conspicuous horns. The pupa is about 1·5 mm. thick and about 6 mm. long. The anterior end is more or less cap-like while the posterior end is more or less flattened. The eclosion of the imago takes place by means of a transverse rupture of the puparium near the anterior end.

Adult.—In general, the male is distinguished from the female by its larger size, and the unequal facets of the contiguous compound eyes. *Head*: Face yellow; compound eyes, deep maroon having a golden hue, and separated from each other at vertex region by a distance of about 0·5 mm. Antennæ are brown or black dorsally and orange ventrally. Arista brown or blackish. Proboscis dark brown. *Thorax* deep blue with a narrow streak at the sides. Scutellum yellow with a smoky pubescence. *Abdomen* shining black dorsally with a pair of yellow spots on the second segment and a yellow band on each of the third, fourth and fifth segments; the band on the fifth segment is thinner than the bands on the third and fourth segments which are more or less equally thick. Distal margin each of the third and the fourth segments has a thin brown border and that of the fifth segment a thick brown one. *Legs* are brownish yellow with their coxæ and trochanters slaty coloured and with their tarsals blackish.

The life-cycle is completed within 15 to 20 days. The incubation period is 3 to 4 days, larval period 7 to 9 days and the pupal period 5 to 6 days.

My thanks are due to N. M. Deshmukh, Esq., Director of Agriculture, Gwalior Government, for helpful encouragement, and to Mr. K. N. Pawar, Chief Chemist, for going through the MSS.

A detailed account will be published elsewhere showing its importance in biological control. The work is in progress.

Agricultural Research Labs.,
Gwalior, R. RAKSHPAL.
April 10, 1945.

POTATO SPROUTS AS A SOURCE OF "SEED"

IN the past various workers have attempted to devise ways of propagating the potato plant by such methods as would reduce the seed rate. The usual method is to plant either the whole or a part of the seed tuber. This asexual mode of propagation is now the universally-employed method of planting potatoes. The only other method so far known is to raise the plants from the true seed. The potato plant being heterozygous yields a variety of new types when either selfed or crossed seed, obtained from the berries, is sown. It is apparent that by this method it is neither possible to maintain a type nor is it profitable to raise a commercial crop; and its usefulness is, therefore, limited to scientific investigations and for the breeding of new varieties.

Seed tubers may be planted whole or as cut-seed-pieces and it has been determined that a seed piece weighing about two ounces is the most desirable size to plant. Thus, for every plant about two-ounce weight of seed tuber is required as an initial start. This high seed rate has come in the way of expansion of potato cultivation, particularly due to transport and other difficulties created by the war. Scientists have, therefore, been busy in

devising ways and means of overcoming these problems. In Russia Lysenko and his associates[1] reduced the weight of seed required per acre by utilization of potato "tops", the remaining 90 per cent. or so of the tuber being used for food purposes. Similar methods of utilizing small portions of eyes called by various names as "chips", "peelings", etc., have been suggested by Copisarow[2] and Evans.[3] Evans has been able to transport potato 'tops' from one place to another by air and claims to have got satisfactory yields. The possibility of utilization and adoption in potato culture of the above and other similar methods has been recently investigated in this country by Pal and Deshmukh[4] and by Sen and Chakarvarti.[5] They have determined that thin pieces from eyes or "peelings" give in general a poorer crop than that raised from the "tops". A suggestion has been offered that a closer spacing might compensate for the decreased yields which they obtained in comparison to the controls (raised from whole tubers).

The above review will show that all the workers have hitherto agreed that detachment of the eyes with either a small or a large piece of the flesh is necessary to raise a potato plant. After the eyes have been sliced off the tuber it serves no further use except in the kitchen. Viewed from another aspect it would mean that a seed tuber, say with ten eyes, has a possibility of giving rise to ten plants at the most, and even this is not practicable as invariably three or four eyes are crowded towards the rose end of the tuber and these when removed serve as one seed-piece.

For the last ten years the Potato Breeding Station at Simla has been engaged on the breeding of better types of potatoes, and it has been necessary to multiply the new varieties rapidly from the original seedling plant. Multiplication of seed, even for a small-scale trial, takes several years. The writer has been therefore, in search of a method by which a tuber could be made to give rise to a very large number of plants, and through persistent efforts has developed a method of tuberless sowing of potatoes which promises to be of value not only for scientific workers engaged in potato investigation but also for potato production, in certain areas.

This new method consists of raising the crop from the sprouts without damaging the eyes. The sprouts when they are about 1 to 2 inches in height are detached from the tuber and suitably planted in beds. Within about a week's time the sprouts develop roots, especially at the basal nodes and within two to three weeks' time the sprouts develop a crown of leaves and at this stage they can be transplanted. The "Sproutlings" are very hardy and except for watering, during the first week or so after transplanting, do not require any other special treatment; in fact, they are as easy to handle as chilli or brinjal seedlings.

Several methods of inducing rapid rooting of sprouts were investigated. Among these pretreatment of sprouts with hormotone was tried out but this did not show ony beneficial results. As the sprouts can be made root readily in soil, where as much as 100 per cent. success has been obtained, no pretreatment of the sprouts seems to be necessary. It may be of interest to mention here that it has also been possible to get plants from sprout cuttings. Some varieties during storage produce very long sprouts and it has been a general practice to detach and throw away all such sprouts before planting of tubers. A long sprout can, however, give rise to three or four sproutlings if suitably treated. The details of the method of obtaining sproutlings are being published shortly.

The use of sprouts as seed is already proving very helpful in rapidly building up the stocks of the new potato varieties at the Simla Potato Breeding Station. There is every reason to believe that satisfactory yields can be obtained through the use of sproutlings. Experiments are in progress at Simla where ways and means of utilization of this method on a commercial scale are being investigated and the results of these findings will be published as the work progresses. In the meantime announcement of this method has been made as this may prove to be of much value, at least in some parts of this country, in the solution of some of the problems connected with the seed potato industry. Each seed tuber is capable of producing a very large number of sprouts. A four-ounce seed tuber would under normal circumstances yield two to four seed pieces, while a tuber of similar size, having about ten eyes, can be made to yield 20-40 good sprouts and the mother-tuber can still be utilized for seed purposes at the end. This is possible because a large number of sprouts develop after the first crop of sprouts has been removed and a tuber is capable of producing two to four such crops. Packets of sprouts have been successfully sent by post, and have rooted well when planted out.

As sprouts do not carry any part of the flesh or the skin, their use as seed reduces the possibility of transmission of tuber-borne fungal or bacterial diseases from the tuber to the soil. Again the tuber often does not show any visible signs of virus infection and it is not, therefore, possible to eliminate the virus-infected ones before the sets are planted out in the field. On the other hand, the 'sproutlings' being transplanted after the first crown of leaves have appeared makes it possible to select only such 'sproutlings' as are apparently free from virus infection. A higher standard of health can thus be expected. The adoption of sproutling method in any scheme of scientific seed-production will thus be of value.

Potato Breeding Station,
Simla, PUSHKARNATH.
April 27, 1944.

* Financed by the Imperial Council of Agricultural Research.

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PHYLLODY OF TIL IN RELATION TO DATE OF SOWING

PHYLLODY, also known as 'Sepaloidy', or 'Green flower' disease, is known to occur in the sesamum crop in various parts of India and Burma. Storey[1] has attributed it to the disturbed physiological conditions induced by the early sowings and heavy rainfall, while Pal[2] suggested that it might possibly be due to a virus. Til (*Sesamum orientale* L.), an important *kharif* season oil-seed crop in Sind, has suffered severely as a result of incidence of this disease. The area under this crop in Sind has decreased from about 42,000 acres in 1934-35 to about 6,000 acres in 1940-41.

In our breeding work, to evolve a high yielding, disease-free type of til, a black-seeded variety, *Jamesabad*-33, has been found to be promising. In order to test the variety and also to determine the optimum period of sowing, a factorial design experiment was conducted for two years with four sowing dates (mid-July, end-July, mid-August and end-August) and two varieties, *viz.*, *Jamesabad*–33 (black-seeded) and *Cawnpore s*–6 (white-seeded). During the second year (1943-44) the experiment was repeated with a slight modification, *i.e.*, another promising variety, *Karho Johi*, was added. During the first year there was a combined attack of the caterpillar (*Antigastra catalaunalis*) and phyllody. The year 1943-44 was characterised by the absence of the caterpillar but there was a severe occurrence of phyllody. This gave an opportunity of gauging the effect of various sowing dates on the occurrence of phyllody. The percentage of its occurrence was recorded in the various sowings and was statistically analysed. The results obtained would be of great interest to other workers in this direction. The data regarding the infection are presented in the following table:—

TABLE I

Percentage of Phyllody during 1943-44

Variety / Sowing	Jamesabad-33	Cawnpore s–6	Karho Johi	Average of sowing	Conclusion
Mid-July (12th July '43)	11·09	22·7	13·20	15·67	Significant at P = 0·01
End-July (27th July '43)	5·66	8·04	6·44	6·71	
Mid-August (12th August' 43)	0·77	0·82	0·78	0·89	Significance difference = 3·161
End-August (27th August' 43)	0·93	2·89	0·60	1·47	

The yield data of the different varieties in the different sowings for two years are tabulated in Table II.

The data presented in Table I clearly indicate that there was a significantly higher attack of phyllody in all the varieties in the mid-July sowing, which continued to decrease till mid-August, after which no significant decrease was observed. Correlating the yields of the various sowings with those of infection percentage, it is seen that there is a corresponding increase in the yield in the mid-August sowings. In the last sowing, though the occurrence of phyllody was less, yet the yield was low, due to diminished vegetative growth. Therefore early sowings appear definitely conducive to the occurrence of the disease. Another fact which is evident from the above is that certain varieties possess considerable resistance to phyllody. Thus the improved black-seeded variety, *Jamesabad*-33, is affected the least while the white-seeded variety, *Cawnpore-s-6*, is significantly more affected. In yield also the variety, *Jamesabad*-33, has given significantly higher yields than the others.

TABLE II

Yields of the Different Varieties for different Sowings

Year	Mean yield in lb. per acre				
	1942–43		1943–44		
Variety / Sowing	Jamesabad 33	Cawnpore s–6	Jamesabad 33	Cawnpore s–6	Karho Johi
Mid-July	568	213	544	254	378
End July	579	363	562	412	542
Mid-August	621	326	604	464	519
End August	513	187	138	22	102

I wish to express my thanks to Dr. T. J. Mirchandani, Officer-in-charge, Agricultural Research Station, Dokri, for valuable suggestions and criticism.

Agricultural Research Station,
Dokri, Sind, M. V. VACHHANI.
May 4, 1945.

1. Storey, H. H., *Rept. East African Agric. Res. Stn. Amani*, 1932–33, p. 16 2. Pal, B. P., *et al.*, *J. Agric. Sci.*, 1935, **5**, 517.

SOME ABNORMALITIES IN COTTON GROWN UNDER CONSTANT LEVELS IN POTS

Two strains of cotton, one *desi* (*G. arboreum* race *bengalense*), strain No. 43, and the other, American (*G. hirsutum*), M.U. 4, were grown in pots with three different constant levels of moisture mainly to study the transpiration of the plants. In the course of the periodical examination of the plants it was found that there were several abnormalities met with and some of the more important ones are recorded here. Such abnormalities were, however, not noticed in the plants of the same varieties grown as a field-crop under normal conditions. It cannot be said whether the abnormal condition of growing the plant in pots that is responsible for these aberrations. The different

moisture levels maintained in the pots had also nothing to do with most of the freaks, inasmuch as, the abnormality concerned was observed not at any particular moisture level only but at all levels.

I. Boll Abnormalities

(*a*) In many of the American cotton bolls an extra erect body resembling very much the gynaceum of the cotton plant with green ovary and dark nigropunctate glands were found in the centre when the bolls dehisced. In a few instances the three- or four-carpelled ovaries of this appendage exhibited minute fuzzy ovules inside them (Fig. *a*).

(*b*) The cotton fibre usually develops on the cotton seed; but a few lint hairs were found to develop both in the American and *desi* varieties from the carpel wall, suture and the ridges of the locules. Again, in American, a tuft of fibres was given out by the apex of the extra gynaceous body as well as the apex of the carpel (Figs. *a*, *b* and *c*).

a *b* *c*

(*c*) In a few Asiatic plants, bolls having three-carpels and in addition a partially developed carpel were recorded.

II. Leaf and Flower Abnormalities

Besides the above abnormality, there were found certain abnormalities with regard to leaf and flowers which are mentioned below :—

(*a*) In the *Desi* cotton grown under higher levels of moisture three leaves having double lamina (mirror image) with a twin petiole joint right through, developed. Another plant under low moisture, put forth two consecutive leaves, the lower leaf having only the right half of the lamina of a normal leaf while the upper developed the left half. The petioles of these leaves were reduced in thickness.

(*b*) A plant grown under low level of moisture produced a flower with two bracts while two plants grown under the highest level of moisture produced flowers having four to seven lanceolate bracts. In a plant grown under optimum condition, a double and a triple flower of different ages were produced on a single pedicel with three common bracts in addition to their own.

The abnormalities of leaves and flowers are not very important but the presence of lint on the carpel walls and lock sutures is very unusual and has not been recorded before. The material grown was from selfed seed of a single plant. While the cause for the boll abnormality is not known, the material has been carefully gathered and will be grown again both in pots and under ordinary conditions to see if the same will be repeated.

The work was carried out in the Cotton Genetics Research Scheme, Indore, financed by the Indian Central Cotton Committee.

Institute of Plant Industry,
Indore, C.I., P. S. Sreenivasan.
May 8, 1945.

LONG SMUT OF SORGHUM-METHOD OF INFECTION

Long-smut of Sorghum caused by *Tolyporium Ehrenbergii* (Kuhn) Pat., has been recorded from India and Africa. In India, it is known to occur in Baluchistan, Sind and Madras. It has been regarded to be not a very destructive disease as the smut attacks only a few grains in an earhead. But in recent years, a survey of the disease was undertaken in Sind, and it was found in the year 1943, that the smut was present practically in every earhead and the number of grains attacked varied from 1 to 30. In India, its presence has been recorded by Butler (1918) and Kulkarni (1918). Kamat (1933) has studied the cultural characters of the fungus and also the effect of temperature on the growth of the fungus in culture. So far no worker has attempted to establish the method of infection of this smut. Butler has suggested that the infection may be a localised one. To determine exactly how this disease appears, this investigation was undertaken.

Effort was made to produce the disease in a number of ways, (*i*) spores of the smut were mixed with seed before sowing, (*ii*) spores were mixed with soil, (*iii*) Moore's vacuum method of infection, (*iv*) spores were dusted on the flowers, (*v*) spores were germinated on potato-dextrose agar and sporidia were obtained in culture. A suspension of sporidia was made in water and a few drops of this suspension were placed in the buds with the help of a pipette.

It was observed that no infection appeared in the case of first four methods. Infection in the case of last method was very successful and ninety per cent. of the infected earheads bore smuted grains. It is quite clear from the above experiment that chlamydospores by themselves do not play any role in the production of the disease. It is the sporidia which take an active part. It is likely that the chlamydospores from the previous crop lie in the soil and the development of favourable conditions, germinate and produce sporidia. These sporidia in turn are carried by means of air to the earheads and produce the disease. Study is being made to confirm the above assumption and also of the factors which induce prolific production of sporidia.

Assistant Mycologist,
Agricultural Research Station,
Sakrand, N. Prasad.
May 23, 1945.

1. Butler, E. J., *Fungi and Disease in Plants*, 1918. Thacker, Spink & Co. 2. Kulkarni, G. S., "Smuts of jowar in Bombay Presidency," *Bulletin* No. 78, 1918. 3. Kamat, M. N., *Phytopath.*, 1933, **33**, No. 12, 985–992.

THE INDIAN FAUNA DURING 1943-44

OFFICIAL statistics of the number of wild animals shot in the various provinces (except Madras) and in Kashmir and Jammu States during 1943-44 are given in the *Indian Forester*.[1] Of the animals that are in grave danger of becoming extinct but now safeguarded by Acts (*viz.*, the Bengal Rhinoceros Preservation Act, 1932, and the Elephant Preservation Act, 1879), only 3 rhinoceroses were killed in the whole of India (in Assam), and 33 wild elephants shot in the several provinces, Assam claiming the maximum (18).

Turning to carnivora, a total of 224 tigers and tigresses were shot, greater number in C.P. and Berar (73) and U.P. (69); of leopard or panther, 211 were shot, U.P. heading the list (50), and 37 each in C.P. and Berar and Bombay. Wild cats claim 91 (58 in Jammu and Kashmir). Of the bears shot, Himalayan black bear leads with 37 (30 in Jammu and Kashmir) and sloth bear 28. Of the deer tribe, the maximum number shot was *cheetal* or spotted deer 511 (Bengal responsible for 211, U.P. 57, C.P. and Berar 108), the number of sambar shot was 235 (95 in U.P. and 53 in C.P. and Berar). Of the 213 barking deer, Bengal is responsible for 120. Nine 4-horned antelopes were also shot.

Other interesting figures are Gaur or bison 38 (13 in Bombay), *nilgai* or blue-bull 212 (119 in Bombay), crocodile 16 (14 in U.P.), python 14 (6 each in Bengal and U.P.). Increase in the number of animals shot over last year's record is noted, in the case of leopard or panther 38; wild cats 76; *nilgai* 106; barking deer 54; *cheetal* or spotted deer 220. This increase in mortality in wild animals is perhaps due to the large increase in the fighting forces in India.

These figures refer to 'Reserve forests' only and are, therefore, no true reflection of the state of affairs. There is no machinery for the collection of figures of the numerous animals shot in the unclassified State forests, grants, grazing land, etc. There is also no record of mortality in the case of games and fishes.

Recently, it was reported in the press that 25 tigers were shot in one district in Assam outside Reserve during 1944, and there is no doubt that game animals and birds are rapidly disappearing in this country. The reason is indiscriminate slaughter of females and immature males in the open season and of both in the closed season, particularly deer and birds and unless Government takes timely action, India's marvellous fauna is doomed to extinction.

In 1935, the Government of India convened a conference of the representatives of all the Provinces and the States in India on the subject of the "Preservation of Wild Life", presided over by the late Mian Sir Fazl-i-Hussain. Since then, Dr. Baini Prashad, formerly Director, Zoological Survey of India, in his address to the Eighth Annual Meeting of the National Institute of Sciences of India in 1943, discussed at length the subject of "Conservation of Wild Life in India". Unfortunately their suggestions have not yet been given effect to. It is now for the relevant post-war reconstruction committee to chalk out a programme, based on the recommendations of these two valuable memoranda.

A wise policy of wild life conservation should provide for: (1) Adequate laws of protection, (2) adequate areas as permanent sanctuaries or refuges for species in their known habitat, (3) adequate organization to enforce the former and administer the latter.

An active unofficial "All-India Organization" for the protection of games, fishes, fauna and flora of India on the models of similar organizations in all progressive countries can also render useful service in this direction. In 1936, the United Provinces inaugurated under the distinguished patronage of Sir Malcolm Hailey (now Lord Hailey), an "Association for the Preservation of Games" in that province, and also started publishing a journal entitled *The Indian Wild Life*. Owing to the abnormal conditions resulting from the war, the activities of this society has received a setback. The United Provinces is also the pioneer in India in passing the "National Parks Act, 1934" that resulted in the conversion of "Hailey Park" to "National Park" with an area of 100 sq. miles. Will other Provinces and States lag behind? What we need most are "National Sanctuaries". The relevant post-war reconstruction committee should bear this in mind.

Botany Department,
Calcutta University, A. K. GHOSH.
June 11, 1945.

1. *Indian Forester*, March 1945, **71**, No. 3.

A PODOSTEMAD FROM THE EASTERN GHAT HILLS IN ORISSA

MEMBERS of the family Podostemonaceæ have been recorded from South India, Ceylon, Eastern Himalayas, Assam, Burma, etc. (*cf.* Hooker,[2] Willis[4]). Recently, Randhawa and Joshi[3] reported the occurrence of a podostemad from the Kumaon Hills, Central Himalayas. According to them, the plant collected by them is to be regarded as a new species of *Zeylanidium* Tul., a sub-genus of *Hydrobryum* Endl. (Willis).[4] Haines[1] previously recorded the occurrence of *Lawia zeylanica*, another member of the family Podostemonaceæ from Orissa. According to him, it occurs in patches on the wet rocks in the rivers of Angul (Cuttack District) in Orissa. He described the same in his *Flora of Bihar and Orissa*.[1] The occurrence of a Podostemad from another locality in Orissa is recorded here and is of interest in connection with the geographical distributon of the family.

The Podostemad collected by the writer has ribbon-like and branching thallus. It was found growing closely attached to wet stones occurring in the hill stream 'Putra gadh' flowing through shady forest in the 'Jolla Mundi' Valley near the village 'Mogal patta' (82° 30': 18° 59') situated about 4-5 miles north off Jeypore, Orissa. It was collected in the

flowering and fruiting stages in the month of January 1938 and was growing in association with a species of *Batrochospermum*. From a comparison of the specimens with characters of the other members of the family, it is found to belong to *Zeylanidium* Tul., which was described by Willis[4] as a sub-genus of *Hydrobryum* Endl. The plant here reported is identified as *Z. lichenoides*. The species has been previously recorded as occurring in Burma, Assam, Bombay Ghats to Travancore and Ceylon.

My thanks are due to Mr. K. C. Jacob (then of the Herbarium, Agricultural College, Coimbatore) for kindly confirming the identification of the species.

Andhra University,
Guntur, J. VENKATESWARLU.
June 30, 1945.

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EFFECT OF PHOTOPERIODIC TREATMENT ON POLLEN FERTILITY

OUT of the five postulated phases in the developmental process of a plant, two have been established with reasonable certainty. Recent evidence[1,2] gives some indications regarding the nature of two new developmental phases.

During the course of investigations on phasic development of wheat at this Institute, it has been observed that the formation of normally functioning gametes depended upon preliminary phasic changes in the cells of the gametophyte brought about by photoperiodic treatment. As the results appear to be of some academic and practical interest a brief preliminary report is made here.

Graded seeds of three varieties of wheat (*Triticum vulgare*), *viz.*, I.P. 165, I.P. 52 and P.C. 591, were germinated and kept for the first twelve days under the following five 'initial' light treatments:—

(1) Complete darkness; (2) six hours of natural light; (3) twelve hours of natural light; (4) same as No. (3) *plus* six hours of artificial light; (5) same as No. (3) *plus* twelve hours of artificial light (200 W. daylight lamp at a distance of 2 ft.).

At the end of this initial light treatment plans were exposed to three photoperiods, *viz.*, (*a*) short-day—6 hr. day; (*b*) normal-day—12 hr. day; and (*c*) long-day—18 hr. day upto the time of anthesis.

Pollen sterility was determined by staining with aceto-carmine and counting the number of stained and unstained grains.

Sterility appears to increase with long as well as short photoperiods, more so in the former case. It is also worthy of note that photoperiodic treatment during the first twelve days has an appreciable effect on pollen sterility. Long-day treatment increases sterility.

TABLE I

Percentage pollen sterility and fertility indices for I.P. 165, I.P. 52 and P.C. 591 wheat (Triticum vulgare) *under different photoperiodic treatments*

Photo-periodic treatment	* Pollen sterility (per cent).			Fertility index		
	I.P. 165	I.P. 52	P.C. 591	I.P. 165	I.P 52	P.C. 591
1 *a*	14·1	21·0	13·8	0·14	0·35	0·06
2 *a*	13·4	19·9	16·4	0·23	0·41	0·23
3 *a*	22·4	15·4	16·7	0·21	0·27	0·22
4 *a*	20·7	16·9	16·9	0·25	0·18	—
5 *a*	19·3	14·9	17·5	0·25	0·15	0·13
1 *b*	2·7	3·4	3·4	0·37	0·44	0·36
2 *b*	2·6	3·4	4·0	0·43	0·39	0·34
3 *b*	1·0	2·4	3·8	0·36	0·40	0·38
4 *b*	3·1	6·7	2·2	0·38	0·41	—
5 *b*	9·8	7·5	8·7	0·31	0·31	0·35
1 *c*	30·4	17·8	23·7	0·13	0·07	0·09
2 *c*	21·7	25·8	21·2	0·17	0·10	0·19
3 *c*	25·5	14·9	19·5	0·14	0·15	0·15
4 *c*	31·5	32·5	25·5	0·10	0·12	—
5 *c*	41·5	30·9	26·2	0·09	0·17	0·13

* Each figure is a mean of 12 observations.

Fertility index within has been calculated by dividing the number of grains per ear by the product of numbers of spikelets per ear and the number of florets per spikelet is also adversely affected by long-day conditions.

The reversible nature of the thermo- and photo-induction effects[2] and abnormalities in development of spike in wheat under the influence of differential photo-treatments, as well as reduction in the number of spikelets and grains under long-day conditions, which have been observed at this Institute (unpublished records of the Imperial Agricultural Research Institute), together with the evidence presented here, as well as the work of O'mara[3] on autotetraploid *Secale cereale* warrant a suggestion that light has an influence on the developmental process in cereals beyond the photophase.

Our thanks are due to Dr. B. P. Pal, and Dr. S. Ramanujam, Imperial and Second Economic Botanists, respectively, for their valuable suggestions and criticisms.

K. K. NANDA.
J. J. CHINOY.

Botany Section,
Imperial Agric. Res. Institute,
New Delhi,
May 30, 1945.

1. Chinoy, J. J., *Curr. Sci.*, 1942, **11**, 400–402. 2. Whyte, R. O., "Imperial Bureau of Plant Genetics", *Bull.*, 1935, 17. 3. O'mara, J. G., *Amer. Naturl.*, 1942, **76**, 386–392.

ON *CASSYTHA FILIFORMIS* LINN.

THE descriptions given for this lauraceous parasite are very meagre and to some extent inaccurate. Some of the latter are given here:

(1) Young parts puberulous (Hooker). They are not so. On the contrary the old stems trailing on the ground are so.

(2) Stem dark-green (Duthie). The extreme tip of the stem is yellow (the first inch or so), lower down it is yellowish green. Further down it is bluish green. The very old stems either dark-green or yellowish brown, the latter colour predominates.

(3) Flowers are 1 inch long when fully formed and fruits 2 inches across (Kanjilal, De and Das). The flowers are hardly 2 mm. across and the ripe fruit including the pulp is not more than 11·0 mm. in diameter lengthwise and 9·30 mm. in diameter equatorwise.

(4) Three bracteoles are present (Duthie). The structures present below the flowers are not bracteoles since they form a part of the flower and lie just below the perianth. When the flower is separated from the inflorescence stalk, these structures also come out and hence they are the epicalyx.

(5) The perianth tube forms the succulent outer covering of the fruit (Hooker). It is not the perianth tube but the perigynous thalamus that forms the outer covering. The perianth is 6, poly-, and in two whorls. Perianth tube cannot be formed in such a case. Moreover this succulent outer covering extends below the true fruit, in between this and the inflorescence stalk, the position naturally occupied by the thalamus.

(6) Whole plants bearing fruits may be dispersed by water (Ridley). This is impossible since the ripe fruit and even flowers and unripe fruits fall down the inflorescence stalk very easily, at just the slightest touch.

C. & S. College,
Shikarpur, Sind, J. SRIVASTAVA.
July 27, 1945.

1. Hooker, *Flora of India*, 1890. 2. Duthie, *Flora of the Upper Gangetic Plains*. 3. Kanjilal, De and Das, *Flora of Assam*. 4. Ridley, *Dispersal of Plants*.

DUAL ARTERIAL SUPPLY OF THE VERMIFORM APPENDIX

THE general impression among the anatomists[1–6] and the surgeons[7] is that the vermiform appendix is supplied by one artery, a branch of ileocæcal artery. In a series of 60 dissections on the Cadaver it was, however, found that in 30 per cent. of the bodies the appendix received more than one artery. In 20 per cent. of these, one twig each from ileocæcal and posterior cæcal arteries; in 8·3 per cent. two from the posterior cæcal artery; and in 1·6 per cent. two from the ileocæcal artery were traced. It is to be noted that whenever the twigs from the posterior cæcal arteries took a total or partial share in supplying appendix, it was always the part nearest the base. These branches, however, are not to be confused with a tiny twig almost invariably given to the base by the posterior cæcal artery.[8]

Even in those cases (70 per cent.) where there was a single appendicular artery it answered to the book description only in 31·6 per cent. In 18·1 per cent., although it was a single branch it immediately divided into two, and in 1·6 per cent. into three twigs, of not inconsiderable size, before entering the meso-appendix. In 18·3 per cent., a single appendicular artery, but a branch of posterior cæcal, was present.

Department of Anatomy,
Dow Medical College,
Hyderabad (Sind), M. A. SHAH.
MUBARIKA SHAH.
June 27, 1945.

1. Beesley and Johnston, T. B., " Quoted by Seshachalan, T., and Gorur, S. R., *Ind. Med. Gaz.*, 1939 **65**, 693. 2. Brash, J. C., and Jamieson, E. B., *Cunningham's Manual of Practical Anatomy*, 1940, 306. 3. Frazer, J. E., *Buchanan's Manual* of *Anatomy*, 1937, 160. 4. Grant, J. C. B., *A Method of Anatomy*, 1938, 160. 5. Johnston, T. B., and Willis, J. *Gray's Anatomy, Descriptive and Applied*, 1942, 766. 6. Le mc Gregor, A., *A Synopsis of Surgical Anatomy*, 1943, 46, 7. Thomson, and Miles, A., Quoted by Sheshachalan T., and Gorur, S. R., *loc. cit.*, 1930. 8. Massie, G., *Surgical Anatomy*, 1944. 235.

ON THE FOOD AND ALIMENTARY CANAL OF THE MILK-FISH *CHANOS CHANOS* (FORSKAL)*

IN the Madras Presidency, the milk-fish contributes to a fishery of moderate scale in the Gulf of Mannar, the Palk Bay and the Pulicat Lake. Its fingerlings, which enter creeks, lagoons and shallow mud flats during the five months from May to September, are collected alive and utilised for cultivation in fish-farms and in brackish and freshwater tanks and reservoirs.

For the purpose of this note, over three hundred specimens, ranging in size from 4 to 43 inches, were examined. The following analysis of the stomach-contents of the fish indicates that it is a plankton feeder: *Conscinodiscus, Fragillaria, Nitzchia, Pleurosigma, Rhizosolenia, Thalassiothrix, Trichodesmium,* Appendicularians, Copepods, fish-eggs, fish-larvæ, larval bivalves, larval gastropods, *Leucifer*, Mysids and species of *Spiratella*.

A study of the anatomical structure of the alimentary canal shows its adaptation to the above kind of food. The mouth is toothless. The pharynx leads into a thick-walled œsophagus, the internal epithelial lining of which is developed into 20-22 oblique plates, on each of which are arranged 15 rows of about seventy spiny papillæ. The œsophagus leads into the stomach, which is a tube developed into a thick-walled muscular gizzard at its pyloric end. Its internal wall is raised into 7 to 9 longitudinal folds. The liver is a bilobed brown structure with the gall bladder placed between the two lobes. The bile duct opens

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into the gizzard by an elliptical opening. The gizzard leads into the intestine through a sphincter muscle. The intestine is a long convoluted tube of uniform thickness. Its anterior portion, the duodenum, is closely apposed to the stomach, and is beset with 120 to 150 brownish tubular pyloric cæca, which open into it by 18 orifices arranged in three yellowish rows of six each. Three cæca are always filled with a yellowish viscid fluid. The internal epithelial lining of the intestine is developed into numerous vascular villii, thus increasing its absorptive surface. The anus is situated closely in front of the urinogenital opening.

It is evident that the structure of the digestive tract of the milk-fish is adapted to its food and feeding habit. The plates of the pharynx act as a filtering apparatus, preventing large and undesirable organisms from entering into the œsophagus. The digestion of the food takes place in the tubular stomach, and is completed in the muscular gizzard, into which the bile duct opens. It is probable that the pyloric cæca are both digestive and absorptive in function. The intestine with its numerous vascular villi is absorptive in function.

Fisheries Branch,
Dept. of Industries & Commerce,
Madras, P. I. CHACKO.
April 26, 1945.

STUDIES IN THE FORMATION OF SULPHUR AT KONA (MASULIPATAM) PART I

IN continuation of our studies[1] of the sulphur formation at Kona near Masulipatam, the soil and the subsoil water in the sulphur-bearing area were found to contain sulphuretted hydrogen, both bound and free; its presence was confirmed by (1) evolution of hydrogen sulphide on acidification of the soils; (2) strong smell of hydrogen-sulphide; and (3) the formation of a heavy black precipitate of lead sulphide on the addition of a solution of lead acetate to the subsoil water.

It was of interest to determine if the production of this sulphuretted-hydrogen was attributable to the direct or indirect activity of micro-organisms.

Samples of soils at various depths from surface up to 6 feet were collected from (*a*) sulphur area and (*b*) non-sulphur area. Weighed quantities of the samples were triturated with measured amounts of sterile water under aseptic conditions and dilutions ranging from 1 : 10 to 1 : 100,000 were effected. These dilutions were used for plating out on nutrient agar fortified with the essential inorganic salts. The plates were incubated at 300° C. both under ærobic and anærobic conditions. Plates were counted in duplicates and only those giving a colony count between 30 and 300 were used for the calculation of bacterial populations. The results are shown in Table I.

It may be observed that anærobic population is much larger (2 to 5 times) in the sulphur-bearing area than the corresponding population of the non-sulphur area.

Samples of these soils were inoculated into Van Deldens' medium (Composition KH_2PO_4 grams; Na-lactate 0·5 grams; Asparagin 0·1 gram; $MgSO_4$ 0·1 gram; $FeSO_4$ traces; Tap-water 100 ml.; and agar 2 grams). pH was adjusted to 7·2, and stab cultures were made to secure the growth of the anærobes. Only one sample—collected at 6 ft. in the sulphur-bearing area—showed distinct blackening after four days' incubation at 30° C.

TABLE I

Number of bacteria per gram of soil

Level from surface	Aerobic		Anærobic	
	Sulphur-bearing area	Sulphur non-bearing area	Sulphur-bearing area	Sulphur non-bearing area
0–1′	3,45,000 2,80,000	5,22,000 6,00,000	very few	very few
1½′	65,000 80,000	1,92,000 2,09,000	3000 2200	,,
2½–3′	72,000 79,000	2,56,000 3,14,000	2500 3100	,,
4–4½′	70,000 81,000	2,58,000 3,00,000	6000 7600	3000
6′	30,000 18,000	25,000 29,000	25000 33200	8000 6300

This culture, which apparently included the sulphate-reducing organism, was transferred to a stock medium devised to simulate the environmental conditions of its natural habitat. The composition was as follows:—

$(NH_4)_2SO_4$ 0·1 gm.; $MnSO_4.3H_2O$ 0·2 gm.; $CaSO_4$ (Gypsum) 1·5 gm.; $MgSO_4.7H_2O$ 0·2 gram; NaCl 4·0 gm.; KH_2PO_4 0·2 gm.; $Fe.Am.SO_4$ 0·1 gm.; distilled water 100 ml.

The pH was adjusted to 7·2. After inoculation and incubation at 30° C. under anærobic condition the yellow precipitate turned black in three to four days.

A systematic study of the micro-organism responsible for the reduction of sulphates has been made and the organism characterised as *Vibrio desulphuricans.*, Konæ.

Vibrio desulphuricans., Konæ

Isolation and habitat.—Occurs in the hydrogen sulphide-forming areas at 6 feet below the surface, in ground water and in the sand, occurring at the same depth.

Morphology and staining.—The organism is a spore-bearing short curved rod with rounded ends, roughly 1-2 μ in length, sometimes forming an S-shaped curve, occurring in groups and rarely singly. It stains well with ordinary aniline dyes like Carbolfuchsin, and is decolourised by Gram's method (Gram−ve). Methylene blue stains the organism quite distinctly when kept for 3-5 minutes. The organism is actively motile and appears to possess a single terminal flagellum.

Cultural and Biological.—The organism is a strict anærobe and prefers a specialised media.

The optimum temperature is 30° C., growth being very poor at lower or higher temperatures. The optimal pH is 7·0-7·4. The thermal death point is 60° C.

The organism grows well in liquid media containing sulphates, sodium chloride, phosphates, sodium lactate, and ammonium salts. Presence of traces of iron salts facilitates growth and renders the visual observation of the reduction easy.

The organism does not reduce nitrates. It accomplishes the reduction of sulphites, thiosulphates and free sulphur.

REDUCTION OF SULPHATES IN SOILS OF KNOWN COMPOSITION

Pure acid-washed sand, moistened with the nutrient solution containing all the essential salts, was intimately mixed and dried at 90°C.; this facilitated an even distribution of the salts in the entire mass of the sand.

Cylindrical jars of uniform size (12″× 1½″) were filled first with about one-third its height with the treated sand; 10 ml. of a uniformly suspended active culture added and then covered with an other batch of the same sand. Each jar contained 250 gms. of the sand. The sand in each jar was wetted with compounded sea-water until a head of 1″ of water remained at the top. A control jar with the sand, identically treated, but with no inoculum, was maintained.

Distinct black bands were visible on the fourth day and these bands gradually developed in width upto about the fifteenth day.

It thus seems justifiable to conclude that *Vibrio desulphuricans*., Konæ is responsible for the production of sulphuretted hydrogen formed in the sulphur-bearing area. Further experiments with a view to initiate the process of sulphate reduction in areas other than the sulphur-bearing areas are in progress. We wish to tender our grateful thanks to the Government of Madras for the generous support of a scheme, of which these studies form a part. Our thanks are also due to Sir J. C. Ghosh for his kind interest in the course of these investigations.

K. K. IYA.
M. SREENIVASAYA.

Section of Fermentation Technology,
Indian Institute of Science,
Bangalore,
August 31, 1945.

1. Iya and Sreenivasaya, "A preliminary study of the Bacterial flora associated with sulphur deposits on the East Coast (Masulipatam)", *Curr. Sci.*, 1944, **13**, (12), 316-17.

ELECTRICAL TRANSMISSION AT NERVE ENDINGS

IN previous communications (Singh and Sehra, 1945; Singh, Sehra and Mrs. Singh; Singh, 1945), we have described differences between the effects of stimulation of the frog heart and unstriated muscle by nerves and by acetylcholine. We have now come across frogs the tissues of which show these differences in a more striking manner.

In the present experiments from gastrœnemius was stimulated electrically, through its nerve, or by acetylcholine (1 in 10^5) and frog rectus was stimulated with alternating current by Winton's method or by acetylcholine. The frog gastrœnemius was stimulated alternately through its nerve and by acetylcholine every five minutes, so that the responses to nerve stimulation and acetylcholine were recorded in the same muscle under identical experimental conditions.

The rectus abdominis was insensitive to acetylcholine, but hypersensitive to alternating current (12 experiments). This was surprising in view of the fact that this muscle is used for the assay of acetylcholine. Out of 12 gastrœnemii, 6 were found to be insensitive to aectylcholine (1 in 10^3), and the other 6 gave feeble responses with 1 in 10^5 acetylcholine, but all these muscles were found to be hyperexcitable to nervous stimulation or to alternating current. It was possible to vary the excitability to these two agencies in the opposite directions. Thus in the absence of calcium, the muscle at first became hyperexcitable to nervous stimulation and acetylcholine, but within 15 minutes, it became inexcitable to the former, but remained hyperexcitable to the latter. As the concentration of calcium was increased, the excitability to nervous stimulation increased, and that to acetylcholine decreased, the optimum concentration of calcium for the former being 0·02 M $CaCl_2$. The muscle could thus be rendered inexcitable to acetylcholine and hyperexcitable to nervous stimulation and *vice versa*. Replacement of the chloride of the saline with bromide, nitrate and iodide at first increased the excitability to both, but after ten minutes affected them in opposite directions (Fig. 1).

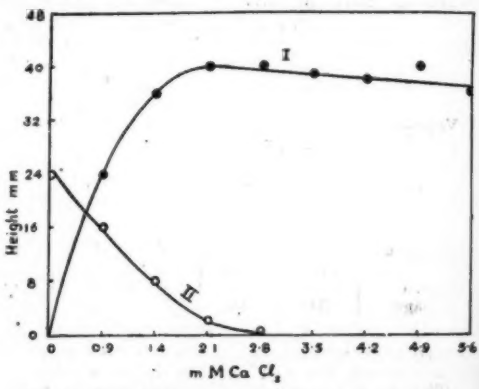

FIG 1.—Frog gastrœnemius. Effect of stimulation through nerve (1st curve) and by acetylcholine (1 in 10^5, 2nd curve) with varying calcium concentration.

Contraction produced by acetylcholine, thus belongs to the potassium group (Singh, 1938), and that by nervous stimulation to the alternating current group. The two are thus antagonistic. As the contraction produced by alternating current is a propagated one, these experiments show that the transmission of the

nervous impulse at the myoneural junction is electrical rather than chemical.

Physiological Laboratory,
INDERJIT SINGH.
MRS. SUNITA INDERJIT SINGH.
Dow Medical College,
Hyderabad (Sind),
July 15, 1945.

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APPARENT CAROTENE AND VITAMIN C IN DEHYDRATED VEGETABLES

It was reported earlier[1] that the purification of crude petroleum ether extracts of carotene by washing with 90 per cent. methyl alcohol is unsatisfactory because some non-carotene, biologically inactive pigments remain in the petrol layer and are estimated inaccurately as carotene. The degradation products which occur in considerable amounts in stored foodstuffs, can be removed by adsorption on a column of dicalcium phosphate. Similar artifacts have been now shown to develop during the dehydration of vegetables and increase on subsequent storage.

An aliquot of the extract, after phase partition was purified by chromatography and the unadsorbed carotene estimated on the Pulfrich photometer. A considerable portion of the "carotene" in the epiphasic layer consisted of some degradation product exhibiting a non-specific absorption spectrum and being chromatographically separable from carotene. It is reported[2] that carotene is reasonably stable in dehydrated vegetables, but when estimated by this method, the loss appears to be serious.

The vegetables were dehydrated as rcommended by Prescott and Proctor[3] and stored in air-tight tins at room temperature.

Mapson's[4] observation that dehydrated vegetables contain reducing substances which interfere with the estimation of ascorbic acid by titration with 2 : 6-dichlorophenolindophenol has been confirmed. Ascorbic acid was determined in vegetables—fresh, blanched, dehydrated, and stored after dehydration—by the method of Harris and Olliver[5] and by the improved method of Mapson where correction can be applied for the non-specific reductants. The results given in Table II indicate that the artifacts which appear to be mainly reductones are developed during the dehydration and increase on storage.

These results emphasise the need for employing the improved technique for the accurate estimation of carotene and ascorbic acid in dehydrated vegetables.

TABLE II.—*Ascorbic acid in mg. per 100 g. of vegetable on moisture-free basis*

Vegetable	Treatment	Harris and Olliver's method	Mapson's method	Non-ascorbic acid reductants
				%
	Fresh	104	104	0
	Blanched	107	107	0
Potato ..	Dehydrated	71·0	70·2	1·2
	Dehydrated and stored for 16 weeks	19·7	12·7	35·5
	Fresh	1480	1480	0
	Blanched	1177	1177	0
Bittergourd	Dehydrated	193	154	20·0
	Dehydrated and stored for 8 weeks	130	100	23·2
	Fresh	549	549	0
	Blanched	439	439	0
Cabbage ..	Dehydrated	300	264	11·9
	Dehydrated and stored for 10 weeks	40·2	23·9	40·4
	Fresh	414	414	0
	Blanched	281	281	0
Spinach ..	Dehydrated	92·9	53·9	42·0
	Dehyrated and stored for 9 weeks	0	—	—

TABLE I.—*Carotene µg. per gram of vegetable on moisture basis*

Vegetable	Fresh			Dehydrated			Dehydrated and stored				
	Phase partition	Chromatography	Non-carotene pigment	Phase partition	Chromatography	Non-carotene pigment	Period of storage	Phase partition	Chromatography	Non-carotene pigment	Loss in carotene
			%			%	Weeks			%	%
Bitter-gourd	25·7	25·7	0	24·1	23·6	2·0	8	22·8	16·6	27·2	35·3
Carrots	855	850	0·6	842	812	3·6	8	469	452	3·7	46·9
Spinach	727	—	—	567	428	24·6	9	331	223	30·6	69·3
Cabbage	341	341	0	280	214	23·6	11	155	74·4	52·0	78·2

S. DATTATREYA RAO.
Y. B. RANGNEKAR.
Department of Biochemistry,
Indian Institute of Science,
Bangalore,
August 31, 1945.

1. Ramasarma, Hakim and Dattatreya Rao, *Curr Sci.*, 1943, **12**, 21. 2. Sekhon, *Indian J. Med. Research*, 1942, **30**, 529. 3. Prescott and Proctor, *Food Technology*, 1937, McGraw Hill. 4. Mapson, *Nature*, 1943, **152**, 13 5. Harris and Olliver, *Biochem. J.*, 1942, **36**, 155.

REVIEWS

Portraits of Famous Physicists with Biographical Accounts. By Henry Crew. (New York: Scripta Mathematica, Yeshiva College), 1942.

In 1937, the editor of the *American Physics Teacher*—now of the *Amercian Journal of Physics*—appointed a committee to plan a portfolio of portraits of eminent physicists, to be published by Scripta Mathematica. The committee contained seven members. It was decided to choose twelve outstanding physicists out of the fifty names submitted for consideration. The selection was to be made from among those not then living.

In February 1938, the following names were selected—Galileo, Huygens, Newton, Ampere, Fresnel, Faraday, Joule, Clausius, Maxwell, Gibbs, Hertz and Rowland. While it is possible to suggest other names for this gallery of twelve, there can hardly be any doubt that these eminent physicists are genuinely great. The period covered by these very distinguished men extends from 1564 (when Galileo was born) to 1903 (the year of the death of Gibbs).

Henry Crew, a member of the committee, has given brief biographical sketches. Emphasis has naturally been laid in each sketch (limited to 800 words) to the outstanding work of the physicist concerned.

The portraits of the twelve distinguished men of science have been taken mostly from contemporary paintings or photographs. The reproductions are attractive and elegant. Facsimiles of letters or parts of written scientific papers are given here and there. These add greatly to the interest of the collection.

S. R. R.

Animal Biology. By A. J. Grove and G. E. Newell. Second Edition. (University Tutorial Press, London), 1945. Pp. viii + 678. Price 16 *Sh.*

The book before us is the second edition of this recent work on elementary biology first published in 1942. The need for a second edition in so short a time is itself a good indication of the very favourable reception that has been accorded to this volume.

In recent times a very notable change in the method of imparting instruction in Biology has taken place. The older method placed great reliance on the type system, a full understanding of a single species being considered the most efficient way of assessing characters that define a group. The method has the advantage that the descriptions given are very precise and often demonstrable in practical work. In actual practice, however, the type method of treatment is apt to underrate the value of comparative study and, often, the plasticity of life in the animal series and variation within orders and phyla are lost sight of. The increasing importance of the functional aspect of animal life has been indicated only in a comparatively small number of text-books. The authors of *Animal Biology* have tried to remedy both these defects. There is a very successful combination of the type method and the comparative treatment; the relation of animal to its environment and the physiological significance of structural features noticed have received attention and emphasis where necessary. The result is an admirable work on Elementary Zoology containing reliable and up-to-date information on biological principles.

The criticisms that one may offer are more of the nature of points of view rather than defects in treatment. In the opinion of the reviewer the omission of Molluscan and Echinoderm types from Part II dealing with metazoan types is certainly a drawback in presenting a well-balanced account of the invertebrates. The sections dealing with vertebrates are particularly to be commended because it is here that the authors have brought in much advanced information on comparative anatomy in a very logical sequence and without subordinating to the description of types. In the method of treatment which most teachers adopt, comparative anatomy of vertebrates is often removed from the detailed treatment of types with the result that the subject loses much of its interest and is often gone through as a necessary rather than a logically developed theme. The departure presented here is a welcome one. The account of chordate embryology is likewise knit into a continuous account of comparative changes taking place during the development of Amphioxus, the frog, the chick and the rabbit. Part VI dealing with Genetics gives a good summary of the subject but the general treatment is not so happy as in the former sections. The last chapter of the book entitled "The Animals' Background" is an original feature and contains much essential information that is often, unfortunately, ignored. On the physiological side it is very pleasing to find the readable accounts of the physiology of sight, the mechanism of hearing, the mechanism of nerve impulses, the behaviour of endocrine systems both in Invertebrates and Vertebrates and the recent work on the physiology of excretion in relation to osmoregulation. The book is very well illustrated; many of the figures are original. A few like Fig. 34 on page 71 and those in the last chapter are not in keeping with the high quality of the other illustrations. The selection of Fig. 11 on page 29 is unfortunate as it does not show the orthodox posture of the Anopheline mosquito. The statement on page 176 in connexion with the green glands of *Astacus* that the fluid within the excretory organs is at a lower osmotic pressure than the blood is misleading; in actual fact the lower osmotic pressure is observed only in the final urine in the bladder, the initial urine being isotonic with blood. Fig. 367 on page 464 with the corpus luteum marked as an unshaded area seems to give a false idea of its structure.

This book can most confidently be recommended to teachers and students alike as a very sound introduction to the study of animal biology. N. K. PANIKKAR.

Principles of Irrigation and Drainage. By K. M. Gururaja Rao, L.Ag., Principal (Retd.), Mysore Agricultural School, Hebbal, Bangalore. (The Bangalore Press, Mysore Road, Bangalore City), 1945. Pp. 50. Illustrations 18. Price Rs. 2.

This timely publication will be found useful against the background of converging efforts of Governments to increase irrigation schemes to insure sustained crop-production against the vagaries of the monsoons. The subject is handled from the standpoint of agricultural needs down to correct methods of application of water on the fields. Books of this type serve to fill in an admirable way the *lacuna* that is growing between theoretical recommendations spread through a number of books on one hand, and the practical needs of the cultivator on the other.

The subject is clearly analysed and presented in five chapters under Irrigation, and four under Drainage. They deal with various aspects of the subject such as: History of irrigation and advantages, soil in relation to irrigation, three ways how water is held in the soil, sources of irrigation water, duty of water, water-lifts, and nine methods of field irrigation. The subject of drainage consists of: Nature of soil in drainage, kinds of drainage, surface "Run-off" of water, discharge-coefficient, different kinds of drains and benefits of sub-surface drainage. There is a small chapter on Alkali soils, with a few suggestions for reclaiming them.

The contents of this attractively got-up volume represent the exceptionally rich and valuable experience, which the author was able to gain during his twenty-five years of intimate association with large-scale irrigation farming; the publication will be welcomed as a practical handbook on the subject.

Animal Colony Maintenance. By E. J. Farris, F. G. Carnochan, C. N. W. Cumming, S. Farber, C. G. Hartman, F. B. Hutt, J. K. Loosli, C. A. Mills and H. L. Ratcliffee. (*Annals of the New York Academy of Sciences*, 46, Art. 1. Published by the Academy, New York), 1945. Pp. 126.

Recent advances in physiology, pathology, pharmacology and particularly in nutrition are largely based on results obtained through animal experimentation. The increasing use of animals for research in these fields calls for the scientific maintenance of a healthy, clean and vigorous stock showing little or no variation from colony to colony. A standardized animal is to the biologist or to the nutritionist what the pure chemical is to the chemist. It is not often recognised that the animal is a delicate bit of apparatus and that the maintenance of a reliable and healthy colony is a complicated problem demanding considerable experience and care. The difficultly of the problem is illustrated by the fact that the simple removal of rats from one building to another may stop breeding for several months. The various aspects of the problems involved were ably discussd at the recent Conference on Animal Colony Maintenance organised by the New York Academy of Sciences, each aspect by a specialist in the field. Six topics are dealt with: genetic purity, mating of mammals, feeding of laboratory animals, environmental influences, infectious diseases, and financial considerations.

The six papers presented at the Conference together with the discussion they provoked have now been published in book form. The introductory speech by Dr. Farris of the Wistar Institute is also included. The papers are all of a high scientific order and are fully referenced. The proper feeding of the various species of laboratory animals and their requirements of the various dietary essentials are dealt with as thoroughly as the many intricate details concerning their œstrus cycle. The infectious and parasitic diseases of laboratory animals are also amply dealt with. The financing of animal colony maintenance has been considered both from the point of view of research organisations and of the commercial breeder. So far as India is concerned, the commercial breeder is almost non-existent, and perhaps rightly so. Most research organisations maintain their own animal colonies reared successfully through generations, and as such the commercial breeder may not have much encouragement.

The book is a mine of information and should prove extremely useful to those concerned with animal experimentation.

S. RANGANATHAN.

Further Work on Plant Injection for Diagnostic and Curative Purposes. By W. A. Roach and W. O. Roberts. (Imperial Bureau of Horticultural and Plantation Crops. Technical Communication No. 16), 1945. 1s. 6d.

At the East Malling Research Station, Kent, England, work on plant injection for diagnostic and curative purposes is being carried out by Dr. Roach and his collaborators for the past many years. In 1938, Dr. Roach surveyed the whole work of plant injection giving details of technique used by himself and others in Technical Communication No. 10, of the Imperial Bureau of Horticultural and Plantation Crops. Since then much advance has been made in the technique by workers in this field and if it were not for the stress of war the Imperial Bureau of Horticultural and Plantation Crops would have brought out another technical communication reviewing the whole work up-to-date. Since this was not possible under the present circumstances, Roach and Roberts in Technical Communication No. 16, have had to confine themselves only to a description of the improvements effected in the injection technique by the East Malling group of workers.

The authors have furnished a list of solutions together with their concentrations which have given responses when tested on a number of plants. The use of these solutions may require modifications when work is done on new kinds of plants. A detailed description is given of the *inter-veinal* and *leaf-stalk* injec-

tion methods which have proved so successful. Since the appliances required for plant injection work are small and require care in handling, details of their construction are given and very clearly illustrated with several text-figures. The results of the extensive work of the authors and their collaborators on plant injection have been briefly summarised in respect of twenty-five different kinds of plants which mainly consists of fruit trees and vegetable plants.

The technique adopted for injection for curative purposes is dealt with under the two heads, *injection of liquids* and *injection of solids*. The latter method being necessary in the case of trees that cannot absorb fluids. The injection of solids necessitates drastic operation on the trees yet it is less elaborate, requires fewer appliances and is more easily carried out.

The techniques described in the communication under review are an improvement over those previously used and described and will be found by workers in the field easy of application.

L. S. S. KUMAR.

SCIENCE NOTES AND NEWS

THE AGE OF THE PUNJAB SALINE SERIES

In the course of his Presidential Address to the National Academy of Sciences at their Annual Meeting held at Hyderabad (Deccan) in December 1943, Prof. Birbal Sahni of Lucknow reported the discovery of numerous microfossils, mostly plant remains, in the rock salt and Kallar of the saline series, as also in the associated gypsum and oil shales; and having satisfied himself regarding the undoubted *in situ* character of these fossils, Prof. Sahni pointed out that the testimony of these fossils was obviously entirely opposed to any idea of the saline beds being so old as the Cambrian; it was clear on the evidence of these fossils, he said, that the beds were certainly Tertiary, and probably belonged to the Eocene period. Prof. Sahni's researches in this field have been more intensively pursued from various aspects during the year 1944, and a full review and discussion of the entire evidence he has collected was embodied in his Presidential Address to the National Academy at their Poona meeting held in December 1944.

In view of the fact that the problem of the age of the saline series is one of the oldest major controversies of Indian Geology, and has "exercised the brains of some of the foremost geologists who have laboured in this country", Prof. Sahni's recent work naturally attracted considerable attention at once and stimulated a thorough review and discussion of all the available evidence—stratigraphical, structural, and palæontological—bearing on this question of the Cambrian *vs.* the Eocene age of the Punjab salt. A special Symposium on this subject was organised at Poona in December 1944 under the joint auspices of the National Academy of Sciences, and the Indian Academy of Sciences, and the papers read at this important meeting have been just published in the *Proceedings of the National Academy* (Section B, Vol. 14, pt. 6). Among the contributors to this symposium, the names of practically all the leading workers in this field appear—C. S. Middlemiss, E. H. Pascoe, C. S. Fox, D. N. Wadia, E. Lehner, E. S. Pinfold, and L. M. Davies,—and there are, in addition, two valuable contributions by E. R. Gee to whom "we owe the most detailed survey of the salt range area since the time of Wynne".

It is hardly possible in the course of this short review to refer to the points raised and comments made by these authors; a perusal of their papers will serve to show how sharply and strongly the opinion is still divided on this question. The whole problem "is again in the melting pot", and the controversy is becoming positively exciting. The Symposium is to be continued at a joint meeting of the Academies to be held at Udaipur in December 1945; and all geologists will be keenly looking forward to the further developments in this field in the hope of arriving at a really final solution of this most intriguing and tantalising problem in Indian Geology.

MAGNETIC NOTES

Magnetic conditions during August 1945 were slightly less disturbed than in the previous month. There were 21 *quiet* days and 10 days of *slight* disturbance as against 19 *quiet* days, 11 days of *slight* disturbance and 1 day of *moderate* disturbance during the same month last year.

The quietest day during the month was the 9th and the day of the largest disturbance the 22nd.

The individual days during the month were classified as shown below :—

Quiet days	Disturbed days
	Slight
1, 3–5, 7–11, 16–21, 23–25, 29–31.	2, 6, 12–15, 22 26–28.

No magnetic storms occurred during the month of August 1945, while one disturbance of moderate intensity was recorded during August 1944.

The mean character figure for the month of August 1945 was 0·32 as against 0·42 for August 1944.

A. S. CHAUBAL.

ERRATA

In the note entitled "A Note on Hotelling's T^2," appearing in Vol. 14, No. 7, July 1945 issue, in page 173, column 2, delete the 13th line reading "industrial and technical establishments trough".

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